

MAXIMUMPC SHOWS YOU HOW TO...

**NO OTHER PC
BUILD-IT MAG
SHOWS YOU
EXACTLY
HOW**

BUILD THE PERFECT PC

Step-by-step instructions for builders AND upgraders



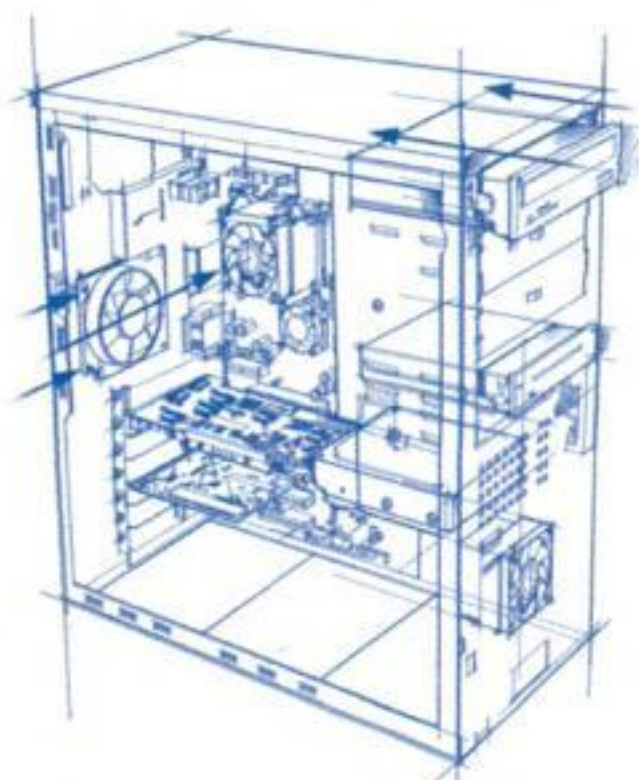
**MORE THAN
30
PRODUCT
PICKS!**

HOW TO PICK THE BEST:

- CPU
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- VIDEOCARD
- HARD DRIVE
- CD BURNER
- DVD BURNER
- SOUND CARD
- POWER SUPPLY
- CASE
- MONITOR
- MINI SYSTEM
- MOUSE
- COOLING

**11-Page Illustrated
Construction Guide**

*Every step and
component explained!*



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I hadn't accidentally emailed my boss that porn link

I hadn't blown my paycheck at vegasbonanza.com



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This One

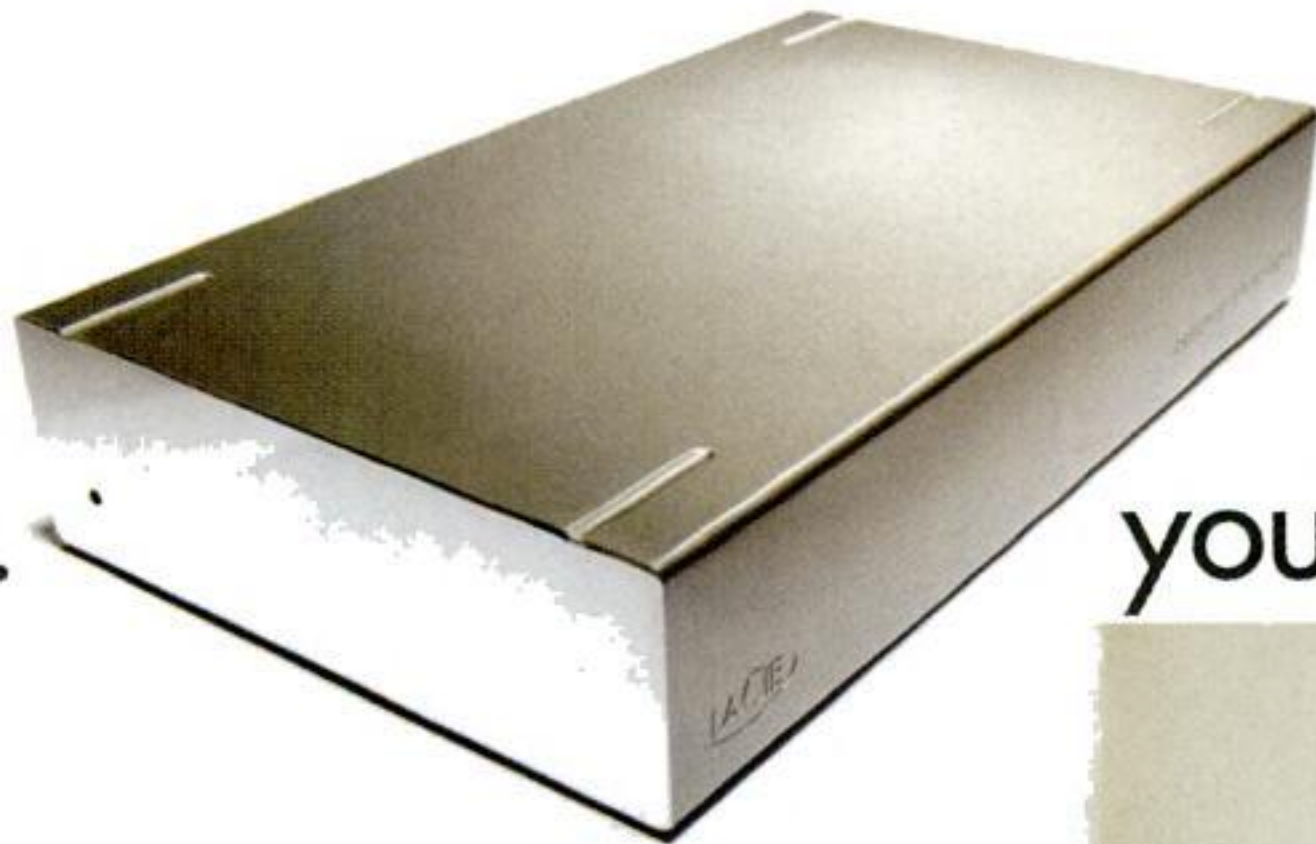


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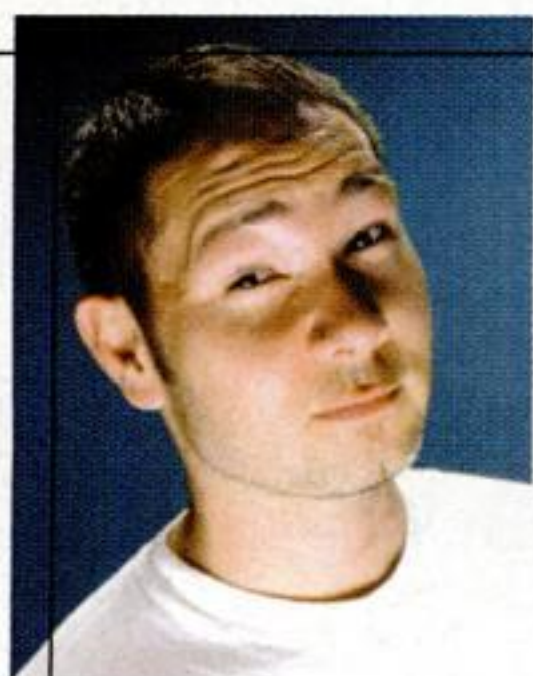
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Release Notes

Cooking With Maximum PC

Building a PC strikes some people as something that must be really hard to do. It seems complicated. It seems the kind of thing—like airplane design—best left to professionals and engineers.

But it's not as hard as something like, say, cooking. Think about it. You've got to troll the supermarket, choosing among thousands of disparate ingredients, almost none of which were designed to work with the others. You risk scalding, poisoning, and being branded for life by a red-hot stove element. Salmonella squats on the counter waiting for the right moment to strike. Knives can't wait to be dropped tip-first onto feet. And all this for what? Less than a half-hour's chow time. And then there are the *dishes*.

Building a PC, on the other hand, is easy. The entire process can be accomplished with the aid of a single screwdriver. Thanks to standards developed over the years, components are designed to work together with a minimum of fuss and cajoling. Check out our "Build It" guide on page 8, and you'll see that if you're talented enough to plug part A into slot B, well, you're already halfway there.

OK, we'll admit that choosing the right components is tough, but that's why we've devoted many of the pages in this special issue to helping you with this very task. You'll learn the essentials of what distinguishes an ordinary piece of gear from a true power-user's pride and joy. And if you haven't got time for the nitty-gritty, you can go directly to the end of each section for our specific component recommendations (along with review excerpts culled from our monthly magazine). Every single recommended part has been tested in the Maximum PC Lab under the most brutal and unforgiving conditions, and only the ones that provide the most bang for the buck get our blessing. Once you've got the parts, we'll walk you through each step of putting them together and making them play well with each other.

Consider the benefits. When you build your own PC, you'll have a no-compromises machine tailored to your own requirements, whether you're building a state-of-the-art gaming rig or a frame-crunching digital video workstation. You can whip together a low-profile home entertainment center for the living room that beats the pants off anybody's TiVo, or supersize to a full-tower case that's sure to impress your friends and frighten your enemies. The best part is that your PC will last for years, a trusted friend and companion, and the heart of your digital life.

And that sure beats cooking.

Salud!

—LOGAN DECKER

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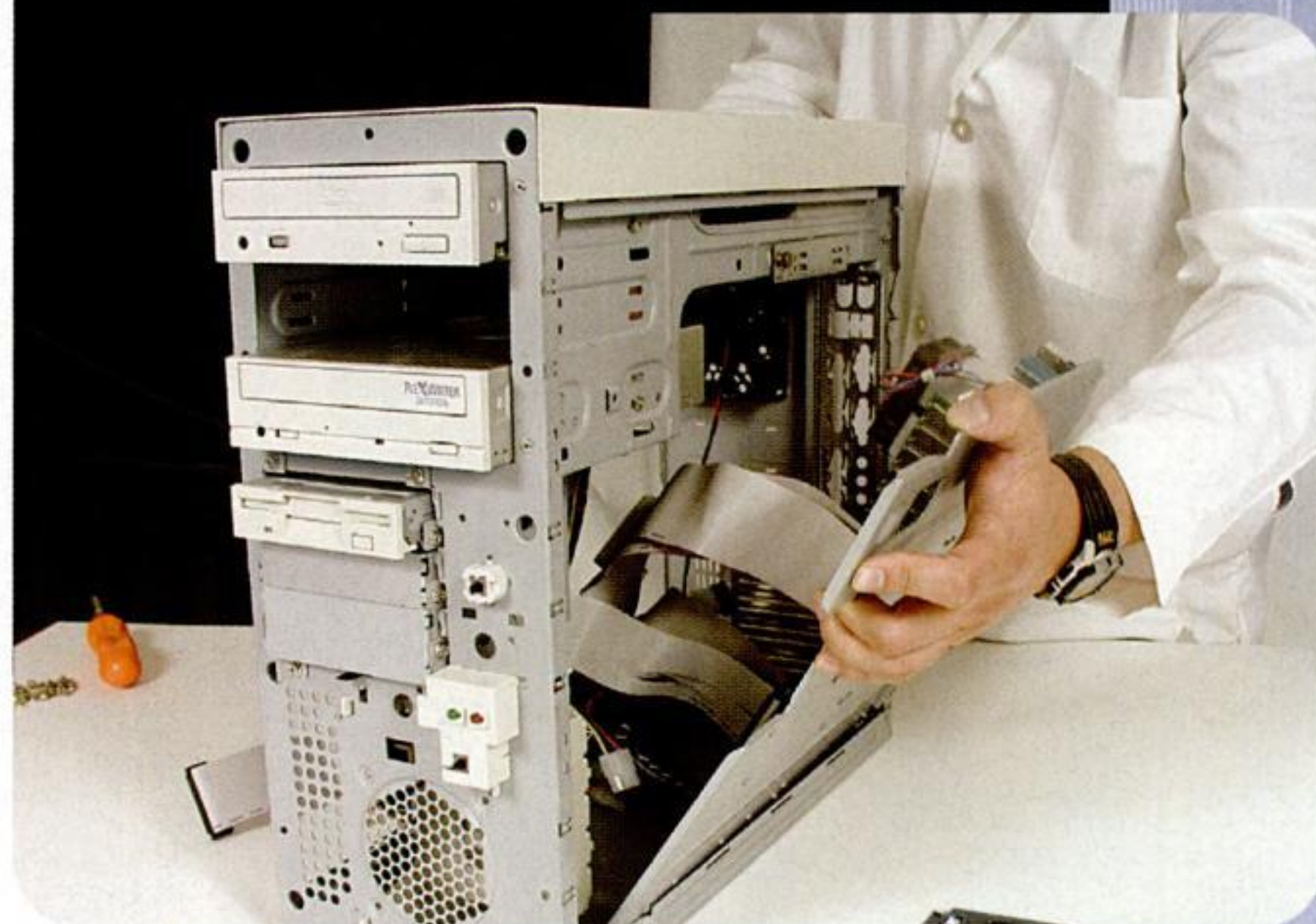
ON THE DISC



We've selected the applications, utilities, and drivers that every new system should have. Load up the drivers, check out the demos.

BUILD IT

From a humble empty case to a smoking-fast rig that's got your name all over it—13 simple steps to assembling your own PC.



ANATOMY OF...

20 A Case

34 A Mobo

44 A Videocard

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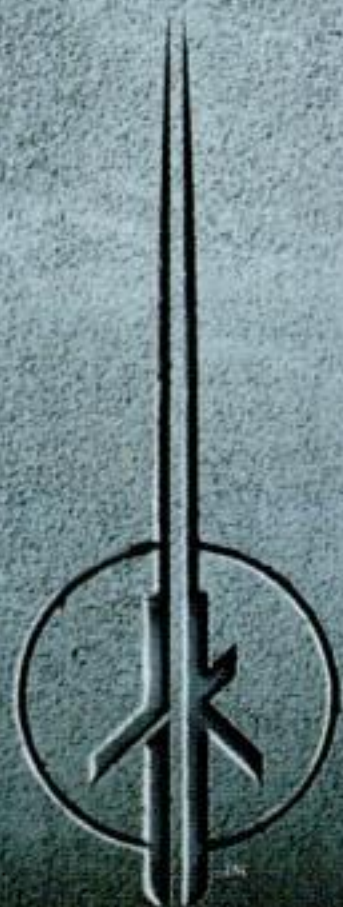
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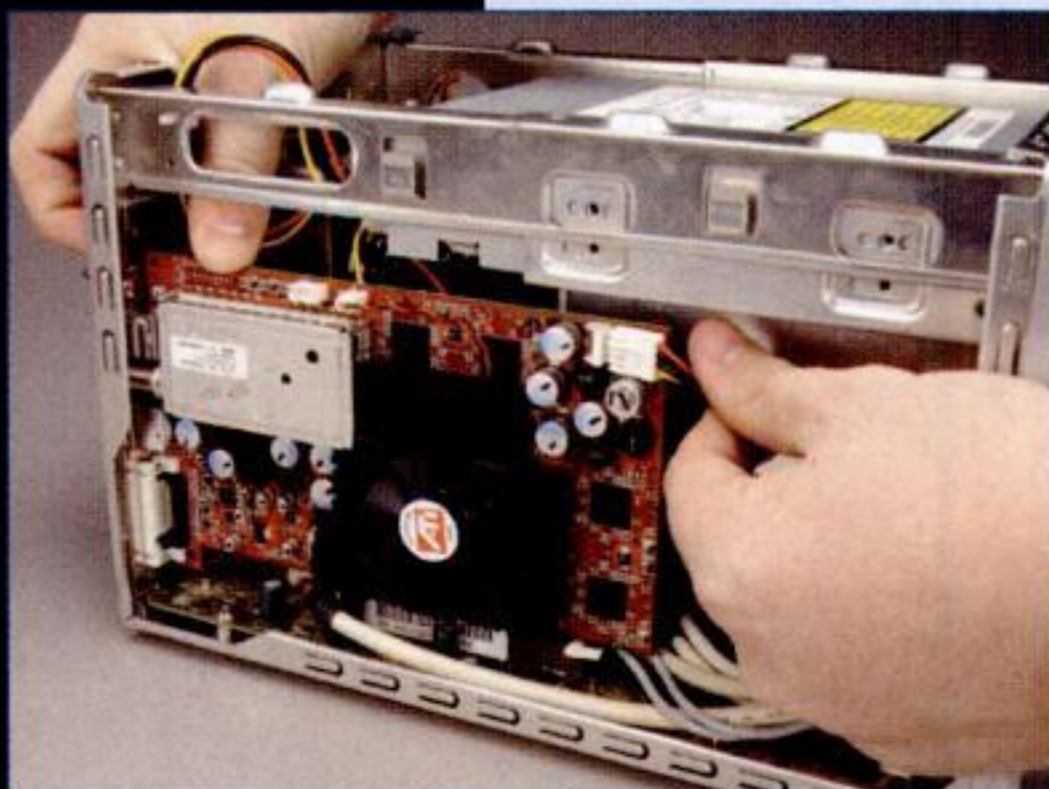


76 SPEC SPEAK

Don't take fright at those strange, alien specs on the boxes of PC components. With our crafty guide to decoding specs, you'll be able to take full advantage of the information.

84 HOW TO BUILD A PC Entertainment Center

The fun has just begun. Here's how to build a tiny PC that will make your game console, DVD player, and TiVo weep with envy.



BUILD THE PERFECT PC 2003

EDITORIAL

Logan Decker EDITOR-IN-CHIEF
Katherine Stevenson MANAGING EDITOR
Greg Vederman DISC EDITOR

ART

Boni Uzilevsky ART DIRECTOR
Mark Madeo PHOTO EDITOR

CONTRIBUTING WRITERS

Omeed Chandra, Brian Lam, Dwight Looi, Jon Phillips, Gordon Mah Ung, Will Smith

PRODUCTION

Richard Lesovoy PRODUCTION DIRECTOR
Lawrence Briseno PRODUCTION COORDINATOR

ADVERTISING

Chris Coelho PUBLISHER
Bernard Lanigan EASTERN AD DIRECTOR
212.768.2966 EXT. 4001
Dave Lynn WESTERN AD DIRECTOR
949.360.4443
Stacey Levy NATIONAL SALES MANAGER
925.964.1205
Sharon Kiernan DIRECT SALES MANAGER
781.416.2018
Nate Hunt NATIONAL ACCT MANAGER
415.656.8536
Jose Urrutia ADVERTISING COORDINATOR
415.656.8313
Kathleen Reilly SENIOR MARKETING MANAGER

CIRCULATION

Tina K. Rodich GROUP CIRCULATION
DIRECTOR
Angela Martinez NEW BUSINESS DIRECTOR
Mimi Hall NEWSSTAND MANAGER
Janet Amistoso DIRECT MARKETING
SPECIALIST

BACK ISSUE REQUESTS

1.800.865.7240

REPRINTS PRINT AND DIGITAL

Reprint Management Services
Maggie French, 717.399.1900 x178
mfrench@reprintbuyer.com

How to contact us:
All subscription inquiries 800.274.3421 or
maxcustserv@cdsfulfillment.com
Editorial staff input@maximumpc.com



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FUTURE NETWORK USA
150 North Hill Dr. Brisbane, CA 94005
415.468.4684 www.futurenetworkusa.com

CHIEF EXECUTIVE Greg Ingham
PRESIDENT Jonathan Simpson-Bint
VICE PRESIDENT/CFO Tom Valentino
VP/EDITORIAL DIRECTOR Matt Firme
VICE PRESIDENT/CIRCULATION Holly Klingel
GENERAL COUNSEL Charles Schug
DIR. OF CENTRAL SERVICES Nancy Durlister

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ON THE DISC



45 Essential Application & Utility Demos & Drivers

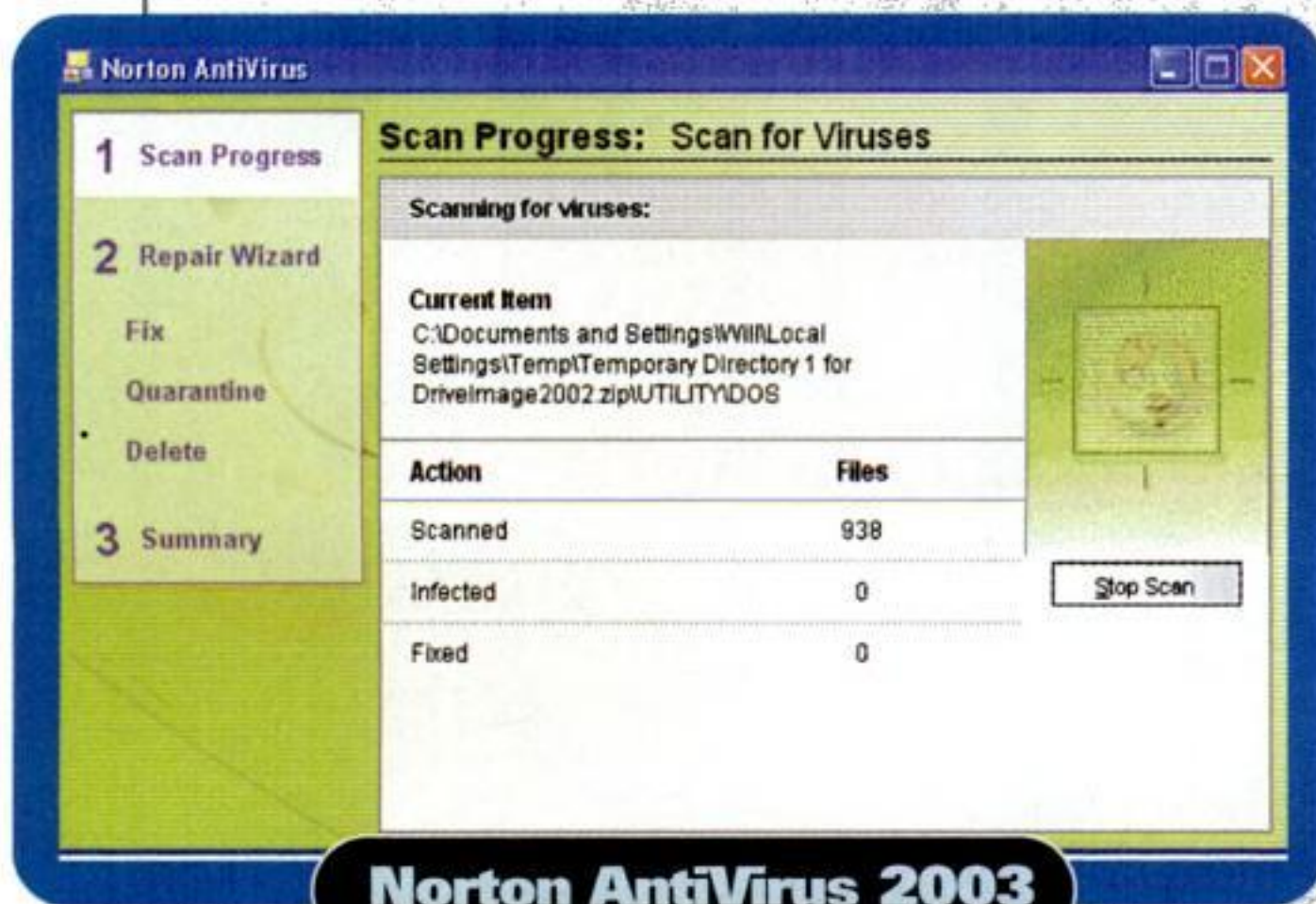
➤ APPLICATIONS

Partition Magic 8.0

Partition Magic allows you to partition your hard drive quickly and easily, so you can have separate sections for multiple operating systems, data storage, and testing areas for unstable programs.

Norton AntiVirus 2003

Norton is one of the oldest, most popular, and most up-to-date AV apps out there. This new version includes Instant Message scanning, in addition to Trojan and worm blocking and removal.



Norton AntiVirus 2003

Diskeeper 7.0 Second Edition

This full-fledged version of the defragger under the hood of Windows XP defrags multiple drives simultaneously in the background, prevents fragmentation of core system files, intelligently determines when to automatically kick in, and bills itself as the fastest defrag technology available.

Zone Alarm Pro 4.0

ZAP provides e-mail filtering, cache cleaning, precision settings, IP tracing, pop-up and ad blocking, password protection, mobile features, cookie handling, and more.

Adobe Premiere 6.0

Adobe Premiere is a pro-level, nonlinear digital video editor. Real-time editing, color correction, audio editing, multiple nestable timelines, multithreading and hyper-threading sup-

port, High Definition, OHCI, ASIO, AAF, and VST support, and more.

Paint Shop Pro 8.01

PSP provides a comprehensive image retouching and manipulation feature set. Enhance images in batches, use manual color correction, and play around with the Background Remover, which allows you to separate elements in fine detail such as hair and grass.

Ulead PhotoImpact 8.0

This image retouching and manipulation program features image editing macros, DVD player slide shows, e-mail attachment optimization, a WYSIWYG web page creation tool, JavaScript functions, extensive text effects, and more.

Agent 1.93

Forte Agent is a Usenet newsreader featuring "ignore" and "watch" lists, integrated e-mail, spellchecking, internal multitasking, advanced searching, and more.

Eudora 5.2.1

Eudora is an e-mail client featuring SSL support, shell extensions, Kerberos V authentication, mail filtering that matches addresses against the address book, word-and-phrase flagging to determine a "mood" level, drag-and-drop attachments, and more.

ACDSee 5.0.1

ACDSee is a powerful thumbnail browser that allows you to edit and convert images in batches, create slide shows, view video files, use multiple browsing techniques, organize chronologically, eliminate duplicates, use free 30-day web image hosting, and order prints online.

FileZilla 2.1.9a

FileZilla is a free open-source FTP client which includes download/upload resuming (when supported by the server), timeout detection, firewall support, GSS Kerberos authentication and encryption, SSL, SFTP, queuing, multi-language support, and more. *FileZilla Server* is available at the web site.

Mozilla 1.4

Mozilla is a premier open-source web browser, mail client, newsreader, WYSIWYG editor, and IRC client. Pop-up filtering, download management, dynamic profile switching, tabbed browsing, Bayesian junkmail filters, e-mail HTML and/or image blocking, yEnc encoding, Palm syncing, newsgroup filters, and more.

Advanced Audio CD Ripper 1.049b

AACR rips CD audio and turns it into MP3s or WMAs using the vaunted and highly configurable LAME codec. Do batch rips from multiple CD-ROM drives simultaneously, and use CDDA/FreeDB integration to automatically complete ID3 tags.

➤ UTILITIES

Undelete 3.0

Undelete replaces the Recycle Bin with a "Recovery" Bin. You can recover files purged from the Bin and even excavate files that were deleted before *Undelete* was installed. Works over a network and includes *SecureDelete*, which can completely wipe sensitive files.

True Image 6.0

True Image operates in the background, creating and restoring disk images without rebooting to DOS, and uses an intuitive XP-style interface. User-defined compression levels, password protection, Windows 95/98/ME support, NTFS, FAT16/32, and more!

PowerStrip 3.45

PowerStrip offers deep configurability for multiple monitors and a massive range of video-cards. Over 500 controls cover color correction, clock speed adjustment, vertical sync, performance tweaks, resource monitoring and optimization, icon management, and more.

WinRAR 3.20

Offers complete support of ZIP and RAR files, and unpacks CAB, ARJ, LZH, and more. Up to 30% better compression with RAR than with ZIP when using this program.

WinACE 2.5

WinACE compresses ACE, ZIP, LHA, MS-CAB,

and JAVA JAR and decompresses ACE, ZIP, LHA, MS-CAB, RAR, ARC, ARJ, and more.

DivX codec 5.05

Create and view DivX videos, a highly compressed but relatively high-quality video file format which can fit a full-length DVD onto a CD. Includes the DivX Player.

XviD 0.92

This is the popular open-source version of the DivX codec. A handy guide is available at <http://doom9.org/xvid-guides.htm>.

➤ EXTRAS

nVidia Windows 2000/XP drivers 45.23

The latest nVidia Win2K/XP drivers for GeForce and TNT cards.

nVidia Windows 95/98/ME drivers 45.23

The latest nVidia Windows 95/98/ME drivers for GeForce and TNT cards.

nVidia Windows NT 4.0 drivers 43.45

The latest nVidia Windows NT 4.0 drivers for GeForce and TNT cards.

ATI Radeon display drivers for Windows XP/2000 3.6

The latest ATI Radeon display drivers for Windows XP and 2000.

ATI Control Panel 3.6

The latest ATI control panel.

ATI Radeon display drivers for Windows 95/98/ME 3.6

The latest ATI Radeon display drivers for Windows 95/98/ME.

Intel 875/865 INF installer 5.0.2.1002

Chipset drivers for the following Intel chipsets: 865 G/PE/P/GV and 875P. Works with Windows 98SE through Windows XP and Server 2003.

nForce unified driver for Windows 2000/XP 2.45

The latest nForce and nForce2 drivers for Windows 2000/XP. For Windows XP, Service

Pack 1 must be installed first. Chaintech 7NJS audio drivers must be obtained from Chaintech (www.chaintech.com.tw).

nForce unified driver for Windows 98SE/ME 2.41

The latest nForce and nForce2 drivers for Windows 98SE/ME. USB2 drivers must be obtained from the individual vendor, and Chaintech 7NJS audio drivers must be obtained from Chaintech (www.chaintech.com.tw).

Windows 95 and 98

First Edition are not supported.

SiS AGP driver for Windows 9x/ME/XP/2000 1.16a

The AGP driver for SiS motherboards for Windows 9x/ME/XP/2000.

SiS IDE driver for Windows 9x/ME/XP/2000 2.03

This will enable PCI IDE bus mastering in SiS motherboards under Windows 9x/ME/XP/2000.

VIA 4-in-1 driver for Windows XP/2000 4.49

Chipset drivers for VIA chipsets. This package will enable IDE bus mastering, AGP support, IRQ routing, and give your chipset proper identification in the Device Manager in Windows XP/2000.

VIA 4-in-1 driver for Windows 95/98/98SE 4.35

These drivers are supported by VIA as being more responsive for Windows 95/98/98SE than the latest 4-in-1 drivers.

Sound Blaster Live! 5.1 drivers for Windows XP/2000

This will install the latest SBLive! 5.1 drivers for XP/2000.

Sound Blaster Live! 5.1 drivers for Windows 95/98/98SE/ME

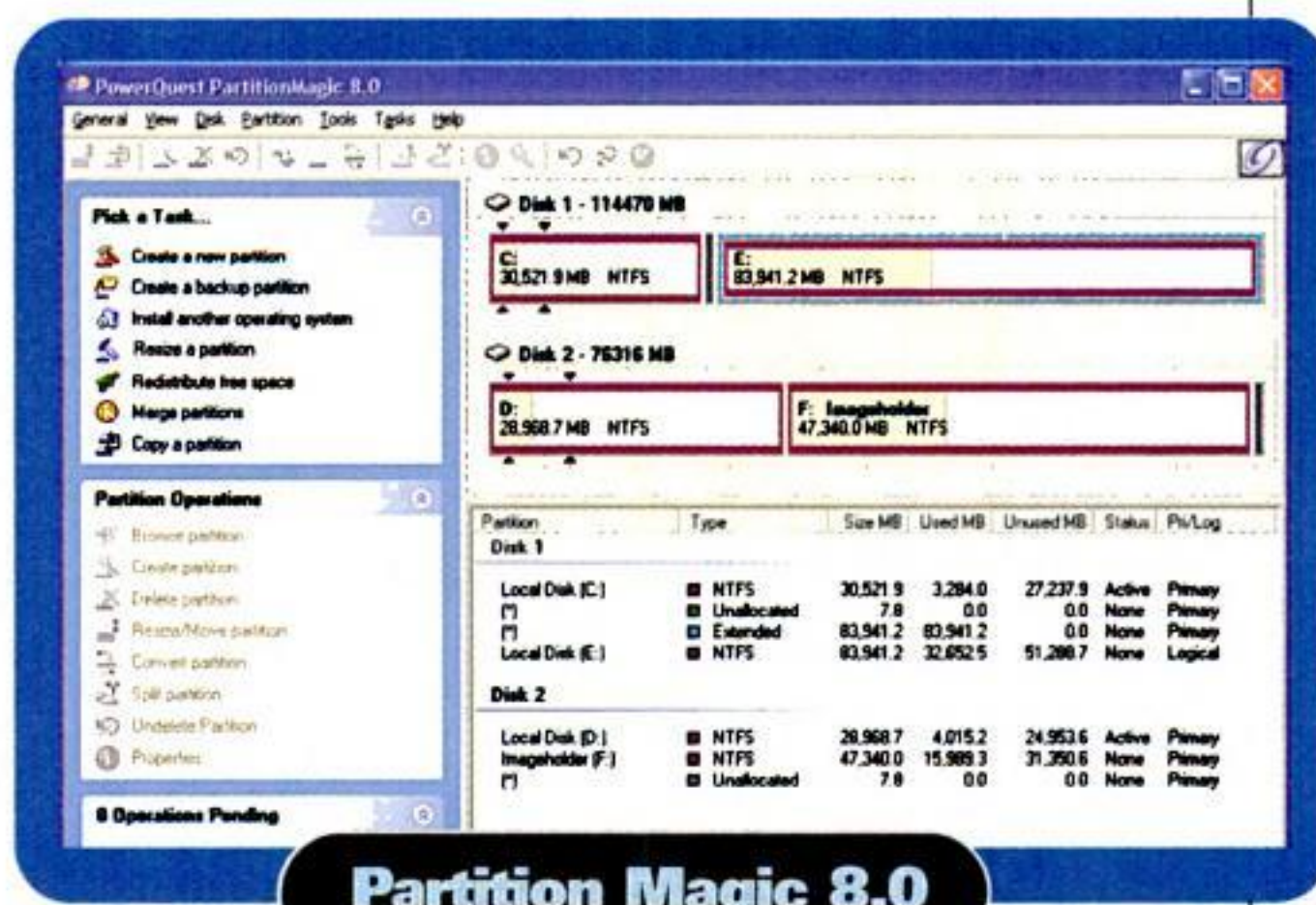
This will install the latest SBLive! 5.1 drivers for 95/98/98SE/ME.

Sound Blaster Audigy drivers for Windows XP/2000

This will install the latest Audigy 1 drivers for XP/2000.

Sound Blaster Audigy 2 drivers for Windows 98/ME/XP/2000

This will install the latest Audigy 2 drivers for Windows 98/ME/XP/2000.



Partition Magic 8.0

DirectX

9.0b

The latest version of DX9 patches a security flaw where a malformed MIDI file could create a buffer overrun. This version does not require an Internet connection during installation.

Windows Media Player 9.0 for Windows XP

Windows Media Player plays just about every major media file, plus will stream Internet media, convert file formats, and burn audio and data CDs.

Windows Media Player for Windows 98SE/ME/2000

Windows Media Player plays just about every major media file, streams Internet media, converts file formats, and burns audio and data CDs.

Microsoft PowerToys for Windows XP

PowerToys is a set of 11 apps that will enable things like icons for Alt+Tab task-switching, virtual desktops, a graphing calculator, and the famous *TweakUI*.

Windows XP Service Pack 1a

The first official compilation of Windows XP Critical Updates.

Microsoft Baseline Security Analyzer 1.1.1

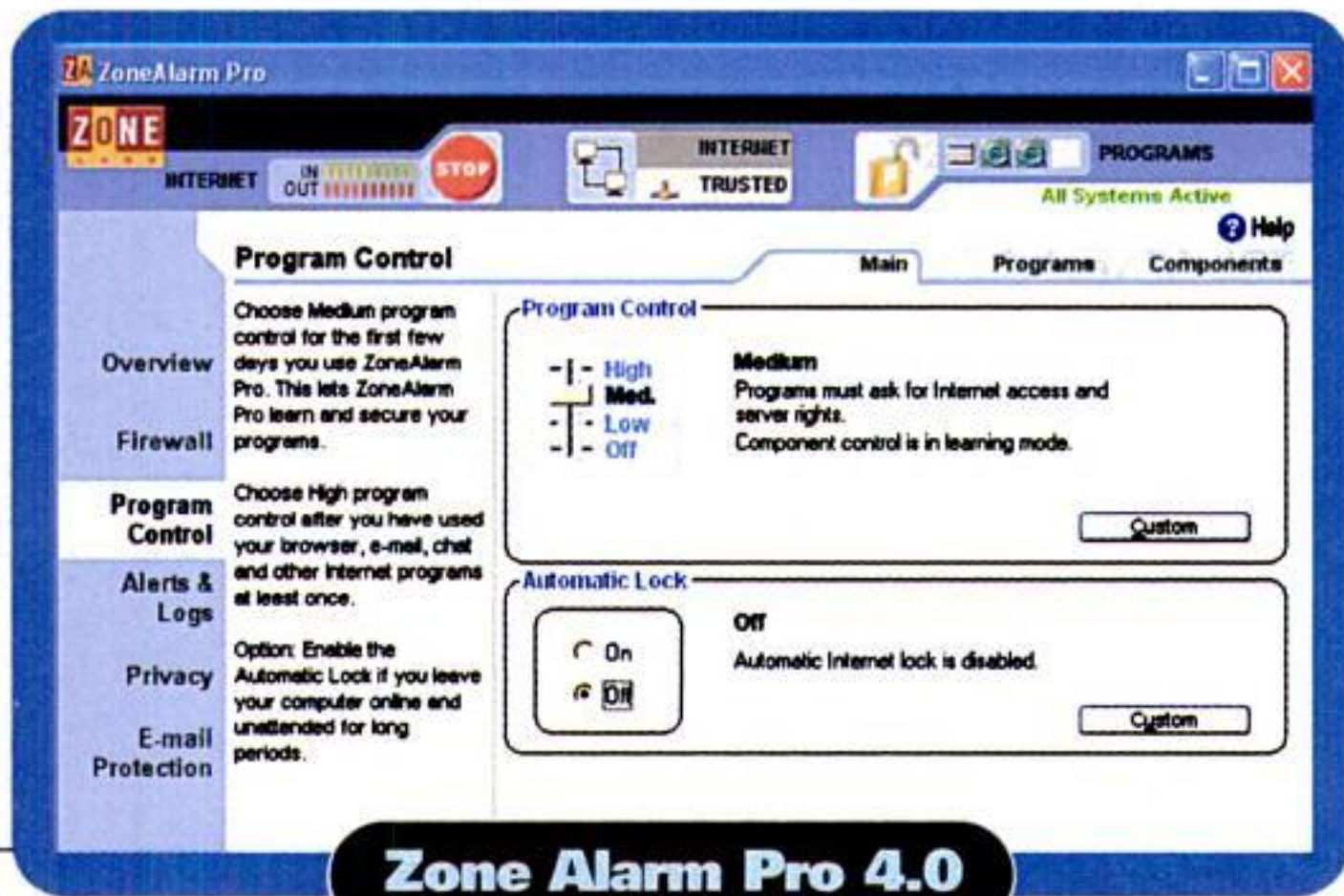
The *MBSA* allows you to scan multiple computers for common security holes and misconfigurations, and will make sure the system is up to date with the latest Windows Update patches.

Microsoft Bootvis 1.3.37.0

Bootvis is designed to trace your system start-up process and optimize it to boot in 30 seconds, resume from Hibernation in 20 seconds, and resume from Standby in 10 seconds.

Microsoft Bootvis Guide 1.3.37.0

This self-extracting ZIP file contains a Microsoft Word document describing in detail how to get the most out of Microsoft Bootvis.



Zone Alarm Pro 4.0

By the Maximum PC Staff

Been thinking about building your own Dream Machine? We bet you have. If you're like most PC enthusiasts, you want to experience true pride of ownership—that indescribable feeling one gets from having built a computer completely from scratch. Sure, you can have fun with a prefab machine, but you'll never really be able to call it your own flesh and blood.

So it's time you built your very own. On the following pages, you'll find the necessary blueprints to conceive, build, and troubleshoot your own PC screamer. You'll get to decide your personal Dream Machine's exact component configuration, one tailored to your personal passions and proclivities. Gamers can splurge on the very, very best videocard and dispense with the funky RAID setup. Videographers can ditch the DVD-ROM and CD-RW drives in favor of a do-it-all DVD/CD combo burner. You make the choices, and you decide on the compromises—that is, if you intend to make any compromises at all.

This guide is just a starting point to help you get moving on the fundamentals of PC building. What you make of this project is limited by only your budget and imagination. You can buy every part we used in the step-by-step tutorial, and configure your PC as a mirror image of our own. Or you can go hog wild with 1GB of memory, SCSI

RAID, and twin plasma screens hooked up to a dual-monitor videocard. Get the idea?

Before you take the plunge, we've got two pieces of advice. Make sure you read this entire issue before you begin buying components. It's an important precaution that will help you avoid, for example, pairing a Serial ATA drive with a motherboard that doesn't have a Serial ATA connector (doh!). Then, thoroughly read this "Build It" article, from beginning to end, before snapping Part A into Part B so you get the "big picture" of the process. Building a PC isn't difficult, but paying close attention to details is absolutely essential if you want a quick, trouble-free assembly.

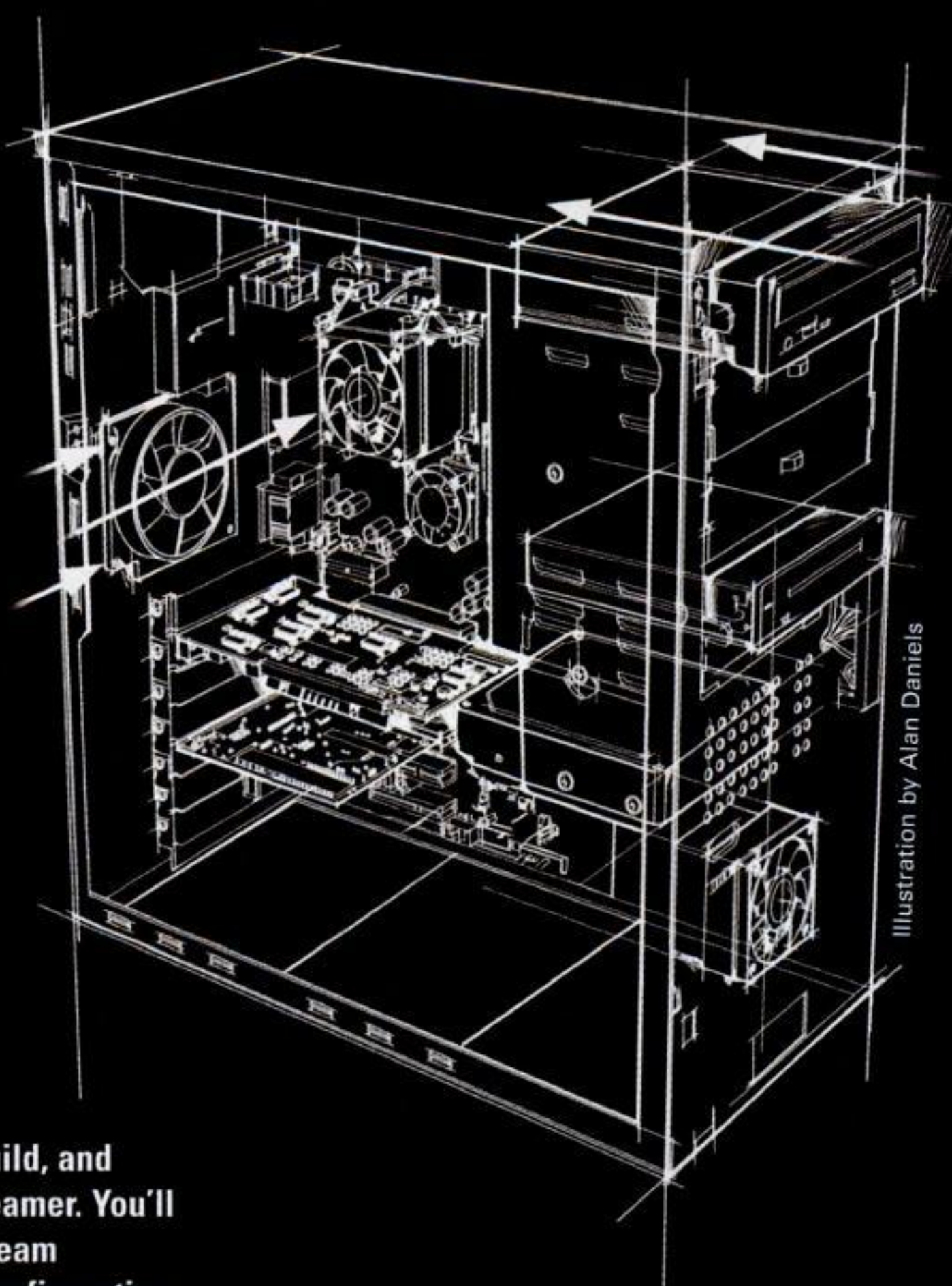


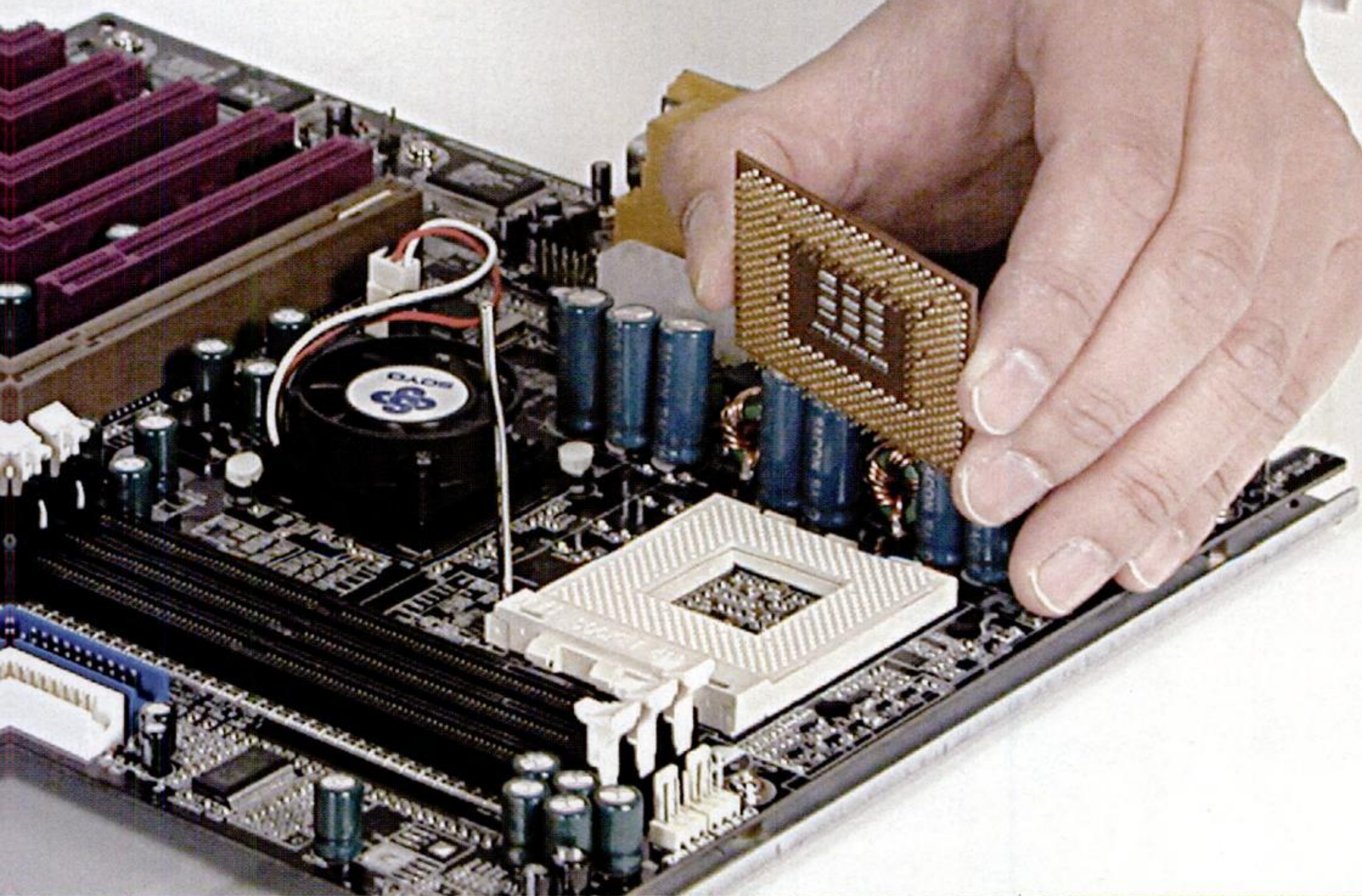
Illustration by Alan Daniels

How to construct the ultimate PC
in less than three hours.

All your questions answered, every step explained.

BUILT

PERFECT

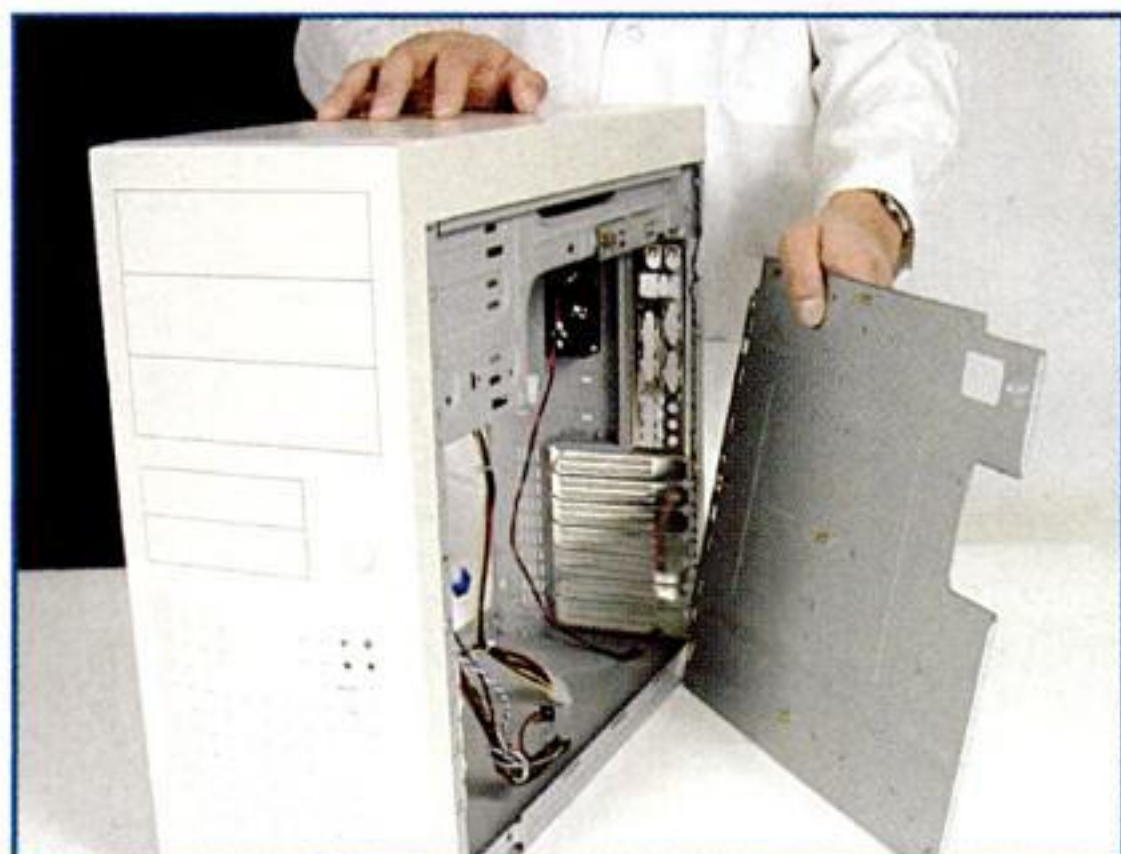


Putting It All Together

Here's a step-by-step guide to putting all of your PC's pieces together. Although your components may differ from the ones we chose, the basic assembly is the same. Just remember to read this whole how-to before diving into your own project.

1 Remove Mobo Tray

Using a case with a removable motherboard tray can make your assembly job much easier. Luckily, our mid-tower case from PC Power and Cooling has a removable tray. The case comes without a power supply, so we ordered the company's 300W Turbo-Cool supply. A good place to build your project



Fewer and fewer companies use removable motherboard trays these days. Fortunately, PC Power and Cooling's mid-tower case includes this amenity.

is in the kitchen, where there's plenty of light and no carpet to create static electricity. If you're in a particularly dry environment where the risk of static discharge is higher, consider getting an antistatic wrist strap from a local electronics store before you touch any items of value.

2 Mount the Motherboard

Begin by matching the mounting holes in the motherboard with the holes in the tray. Ideally, brass or aluminum standoffs should be used to support the motherboard in all four corners, as well as in the center. If your tray doesn't have a screw hole in a section of the motherboard that you'll be applying pressure to (such as near the IDE cables or PCI slots), then you can use plastic standoffs for additional structural integrity.

Make sure you can account for all the metal standoffs you've used. An errant metal standoff that's poking into a random point of the motherboard could potentially short out the PC. Also, be sure to firmly screw down any brass standoffs so they don't back off by accident. Once you've mounted the motherboard, you should push on different sections of it to make sure it feels solid.

Our Soyo motherboard uses a BIOS setup menu to configure most of the board's essential settings, but other motherboards may require that you switch physical jumpers to change settings. Now would be a good time to familiarize yourself with where these jumpers reside and what they do. For our motherboard, we did have to throw a jumper to instruct the onboard RAID controller to act as a normal ATA/100 controller for our single IDE drive.



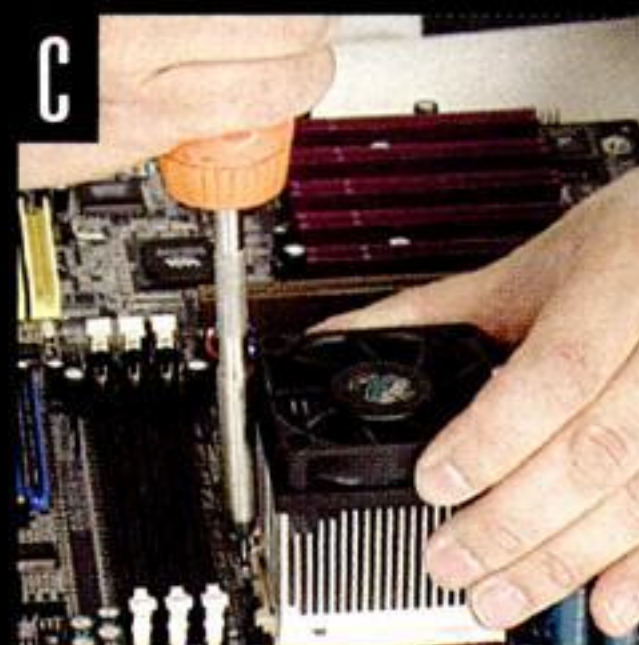
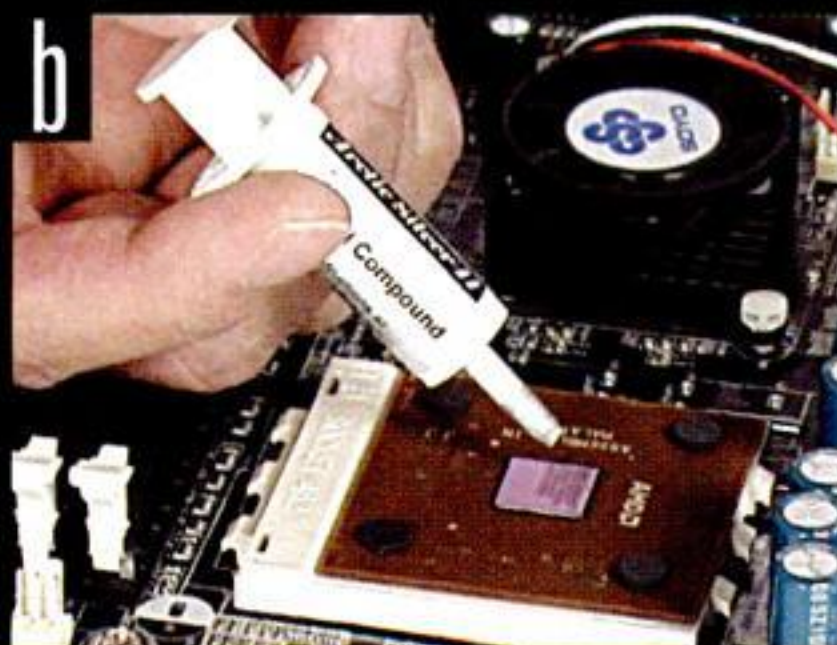
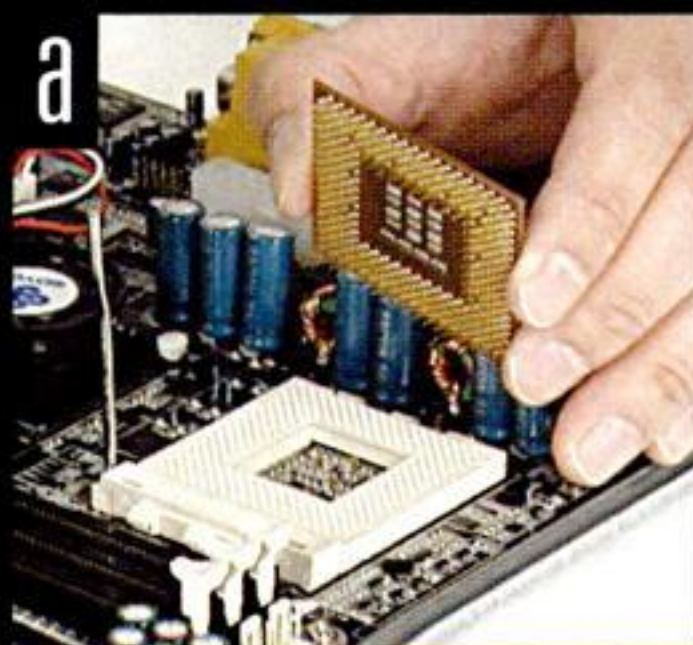
(a) Make sure the I/O shield that came with your case or motherboard matches the I/O holes on the motherboard.

(b) Make sure the standoffs are tightened so they don't back off.

(c) When screwing the motherboard into the backplate, leave it a little loose while you ensure that PCI cards will fit properly, then tighten the screw.

3 Install the CPU

Modern CPUs are as delicate as butterflies. Don't manhandle them. To install a socketed CPU, lift the arm on the socket straight up in the open position. You'll notice that pins are missing from two corners of the Athlon XP (only one corner is missing pins on a Socket 478 Pentium 4). These notched corners should match the two notched corners of the socket. Drop the CPU straight into the socket, and take care not to bend any pins



(see a). Once the CPU is sitting flat in the socket, lock the arm back down.

If you're sure your heatsink already has a thermal pad or thermal tape on it, you don't need to apply thermal compound. Our heatsink came "raw," so we used Arctic Silver II thermal compound for its low electrical conductivity and good heat transfer characteristics. A tiny 1mm or 2mm dab of goop is generally sufficient; apply it to the core (see b). Use enough to cover the core, but not so much that it oozes all over the CPU and motherboard. Obviously, you'll want to use more thermal compound for Pentium 4s with their larger cores. You can find more instructions at www.articsilver.com.

Mount the heatsink fan by placing the fan flat against the CPU. Clip one side of the heatsink to the socket. To clip the other side, use a screwdriver or needlenose pliers to nudge the other clip into place (see c). Press on only the clip and keep the heatsink flat on the CPU, not at an angle. BE VERY CAREFUL—it's ridiculously easy to crush AMD CPUs during heatsink application. While you're here, plug the fan into a nearby power header that's marked CPU1.

4

Accessorize the Mobo with Memory, Cables, and Wires

It's time to install RAM, cables, and the front-panel connectors. Open your motherboard manual and determine which memory slot should be populated first. Some motherboard makers

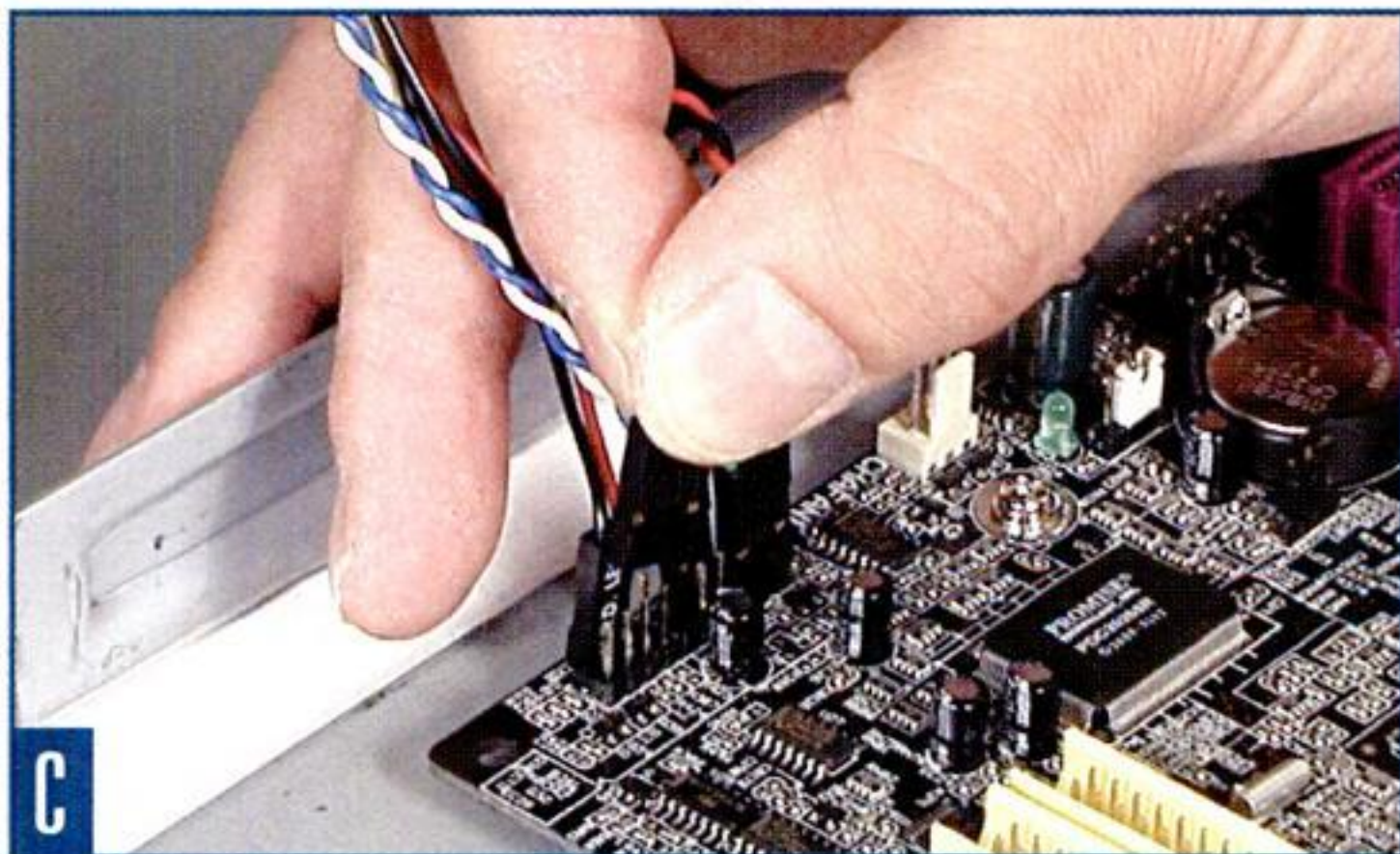
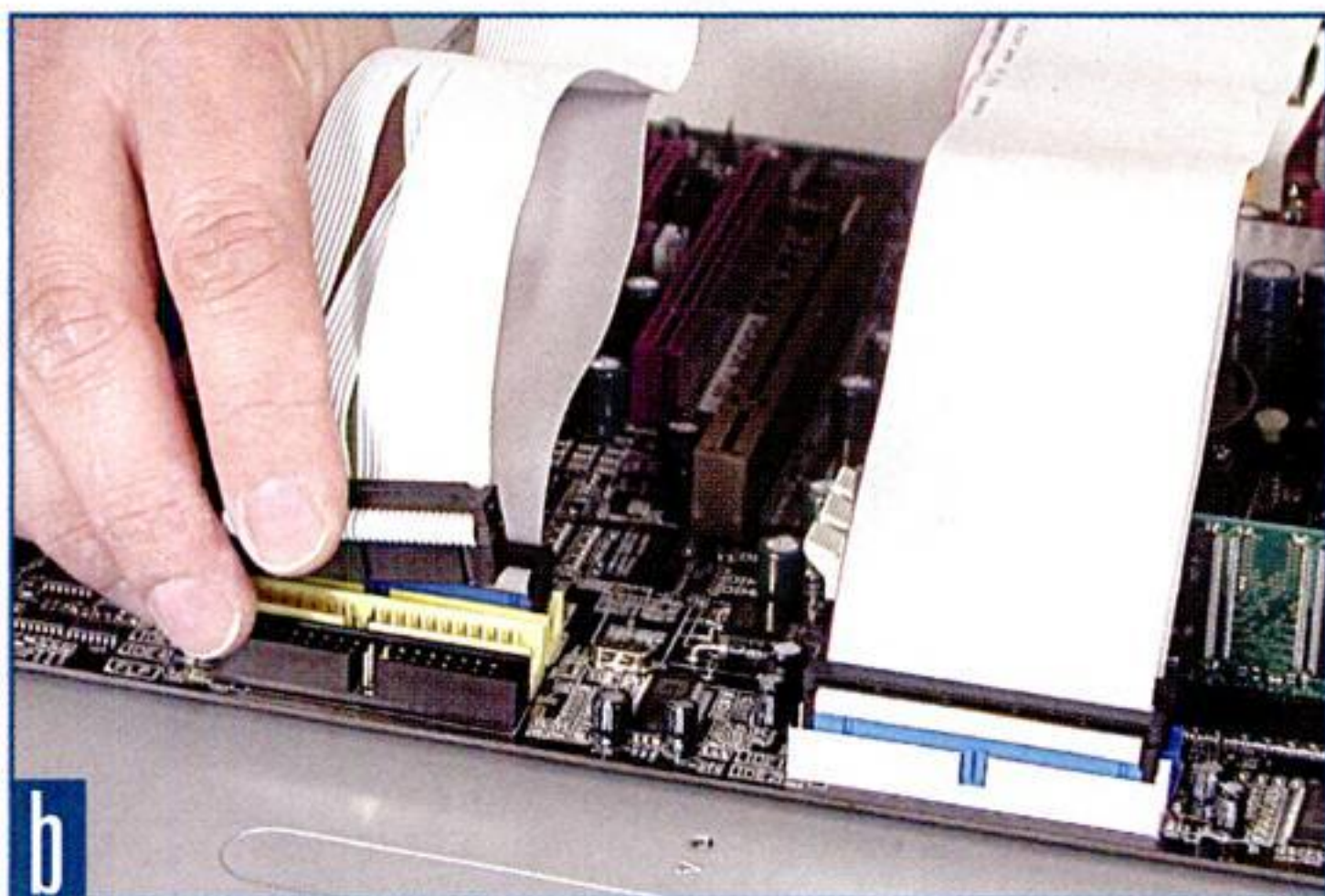
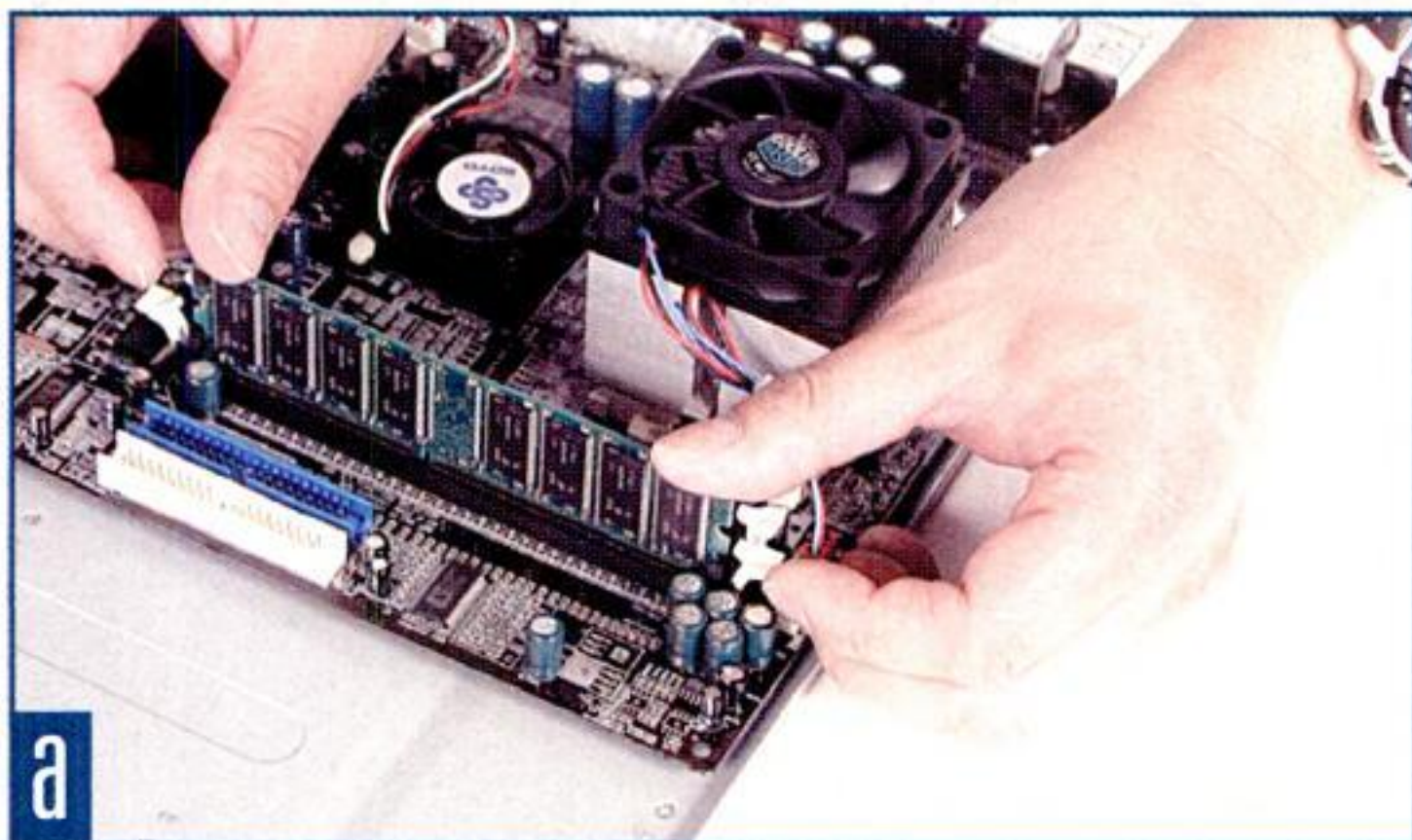
actually label the slots 1, 2, and 3. While your RAM may ostensibly work fine in any memory slot, using the correct slot can help ensure trouble-free performance. PC100 and PC133 memory modules boast two notches that make

it easy to determine which way the memory fits into the slots. But the DDR memory module that we used has just one notch, and it's nearly in the middle of the module, making it easy to inadvertently insert the memory in the wrong direction. Line up the notches and press the memory into the slot until it locks into place (see a).

Now insert the IDE cables. The cables

should be notched to fit in only one direction (see b). Use the fine-wired 80-pin conductor cables for your hard drives, and the coarse-wired 40-pin cables for your optical and removable storage drives. Try to keep the boot hard drive on the primary IDE channel, and try to keep optical drives on separate channels—high-speed CD burners won't perform at full spec if they're pulling data from a CD-ROM drive that's sitting on the same channel. In our case, we actually isolated all of our IDE drives on their own channels by using the mobo's two regular IDE channels, as well as the two extra IDE channels enabled by the motherboard's onboard IDE RAID controller. (Unless your system is equipped with an IDE RAID controller, you'll have only two IDE channels total.)

Finally, carefully examine the motherboard and its manual to determine which way to connect the power-on, reset, and hard-disk activity lights located on your PC's front panel (see c). If you put the connectors in backward, you won't kill anything, but the lights won't work.

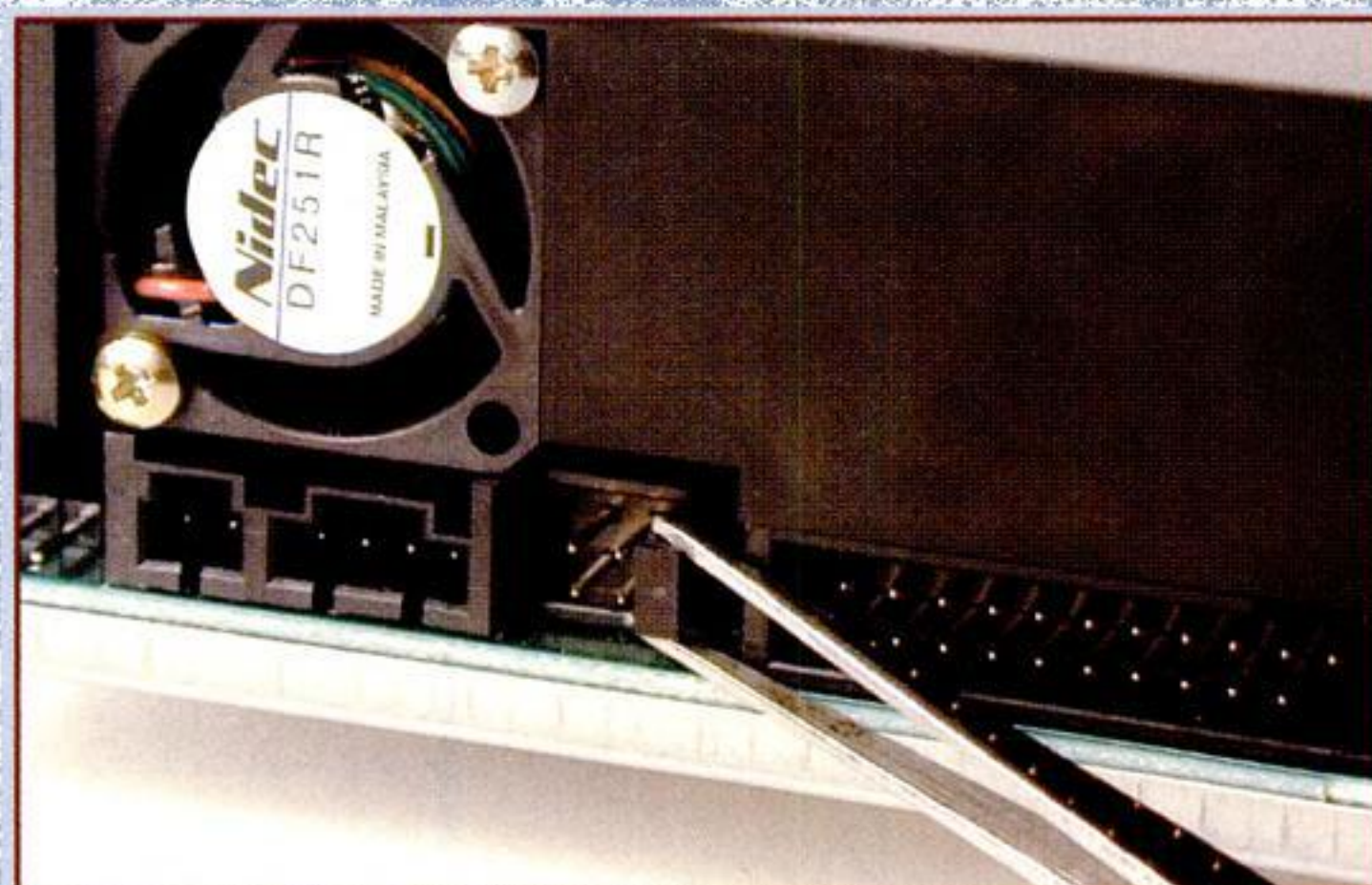


(a) Before you rush out and buy the largest chunk of memory you can find, make sure the memory type is supported by your motherboard. You should also verify which slot to use if you're populating your board with only one stick of memory. (b) Most motherboards come with their own IDE cables. Usually, the blue connector goes on the motherboard. (c) No one ever connects the front panel connectors correctly the first time. If your new PC won't boot at first, make sure your power switch connector has been inserted properly.

5 Set IDE Master/Slave Jumpers

This step is for everyone who doesn't have access to four IDE channels and might need to put two IDE devices on a single channel.

Let's say you have three IDE drives: one hard drive, one DVD-ROM drive, and one CD-RW drive. Because each IDE channel supports two devices, you can accommodate all your drives—but you'll need to set each drive in the proper position. You'll want to plug the hard drive into the master interface of the primary IDE channel; the DVD-ROM drive into the slave interface of the primary channel; and the CD-RW drive into the master interface of the secondary channel. Now for the kicker: Each IDE device must be appropriately set as either a master or slave device. You can do this by setting a jumper on the back of each drive; a little map next to the jumpers will indicate proper settings. To ensure reliable operation, we recommend that you eschew the "cable select" option and instead opt for either a master or slave setting.



The jumpers on the back of an IDE drive usually let you choose master, slave, or cable select. Move the jumper around to change the relationship.

6 Slap in the Drives

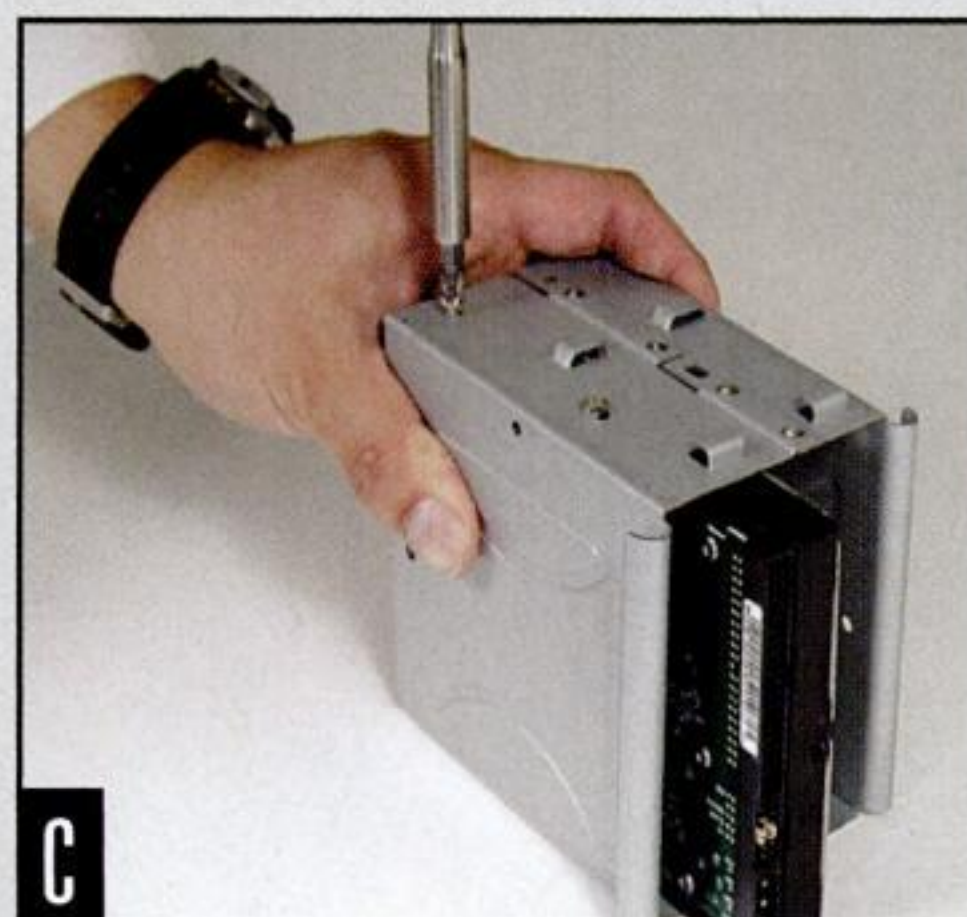
We staggered our CD-RW drive and DVD-ROM drive in order to keep an empty drive bay between the devices. Stacking optical drives on top of each other usually won't hurt anything, but it makes sense to encourage as much airflow as possible inside your case. Because our mid-tower case is intended to sit on the floor, and because our DVD-ROM drive will be used to play DVD movies and audio CDs, we

placed the DVD-ROM drive in the top bay for convenience. We have a small case, so we weren't worried about the length of our IDE cables. But if you're using a relatively tall case, remember to get extended IDE and floppy cables.

When actually screwing your drives into the case, we recommend that you do so on both sides of the drive—this will require removing the starboard-side case cover. Today's optical drives spin at

increasingly high speeds, and excessive vibration or rattling can actually hurt performance, so you'll want your drives properly secured to your chassis. We recommend that you use a non-magnetized screwdriver for this type of work.

Go ahead and mount your optical drives and floppy drive (if you have one), and pop in the front case bezel if it's been removed. Since both sides of your case are open at this point, take the time to align the floppy and optical drives so they sit flush with the front case bezel. If you have a hard drive gondola like the one that came with our case, screw your hard drive into it. Just don't insert the gondola back into the case; we'll get to that later.



(a) We put the PlexWriter CD-RW drive on the bottom and the Pioneer DVD-ROM drive on top because we'll want quicker access to the DVD-ROM drive—but that's just us. (b) The floppy drive is the PC's appendix—but we kept it in our project for sentimental reasons. (c) It's important to tightly fasten screws on both sides of your IDE drives, such as this 7200rpm hard drive. Excessive rattling may hurt the performance.

7 Put the Motherboard in the Case

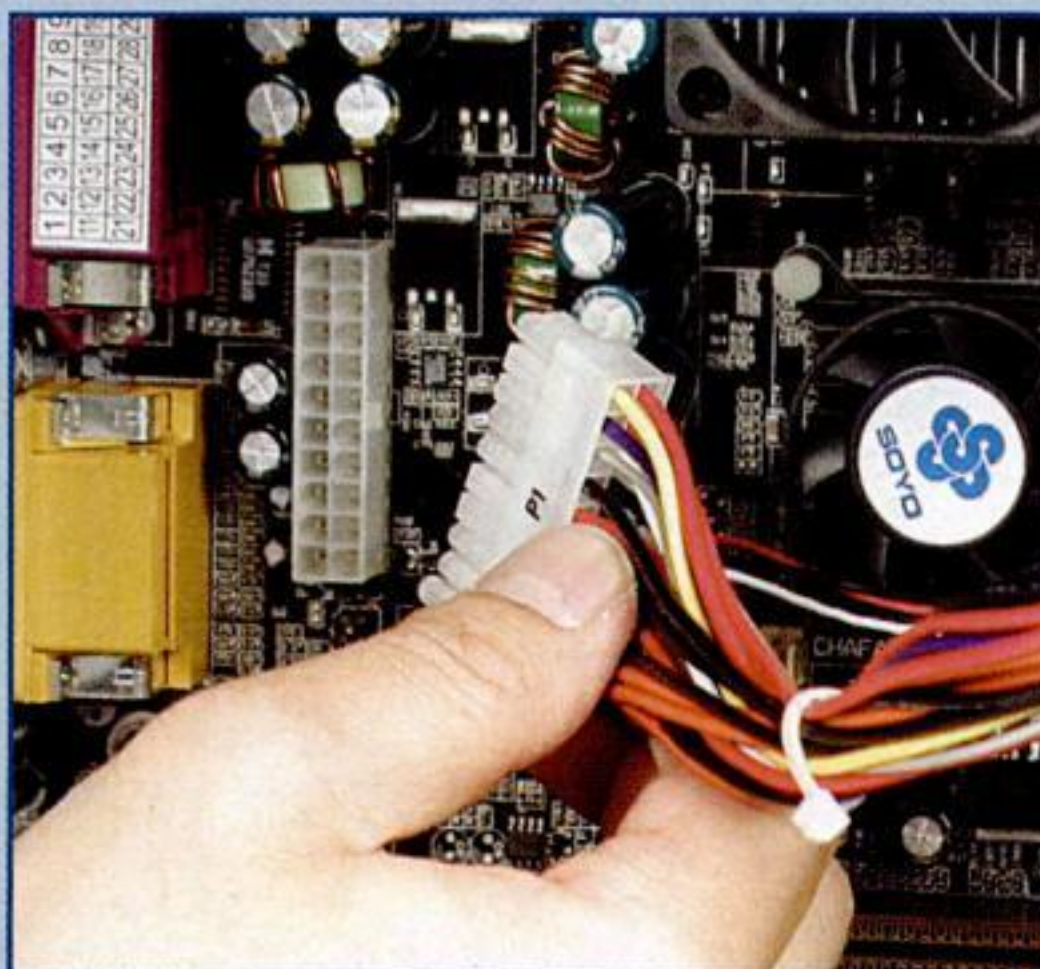
It's now time to fit the whole motherboard enchilada into the case—but before you do, make sure the holes in your case's metal I/O shield match the I/O ports on your motherboard. Also, make sure all the shield's metal holes are punched out. If the holes don't match the ports, don't proceed! Get a proper I/O shield to save yourself heartbreak down the line. When you install the motherboard tray into the PC, make sure you don't crimp any cables. We usually leave the motherboard screws a tiny bit loose and tighten them only after we're sure there's enough space between the back of our PCI add-in cards and the edge of the motherboard.



Fold in the motherboard tray carefully, and check to see if the case's I/O shield matches your motherboard I/O ports.

8 Connect the Power

Match the clip of the 20-pin power connector with the notch in the plug, and firmly clip it in place. Like most desktop Athlon mobos, our Soyo needs just the 20-pin for power. Motherboards for the Pentium 4 add a small four-pin connector (labeled 12V) for additional 12-volt power needed by the CPU. So, if you're building a Pentium 4, attach that connector as well. For all power connections, check your motherboard manual for anomalies. Some boards, such as the original Athlon MP mobos, use proprietary plugs. Many dual Athlon boards also make use of the 12V connector, and may require that you plug a hard drive power plug directly from the power supply into the motherboard.

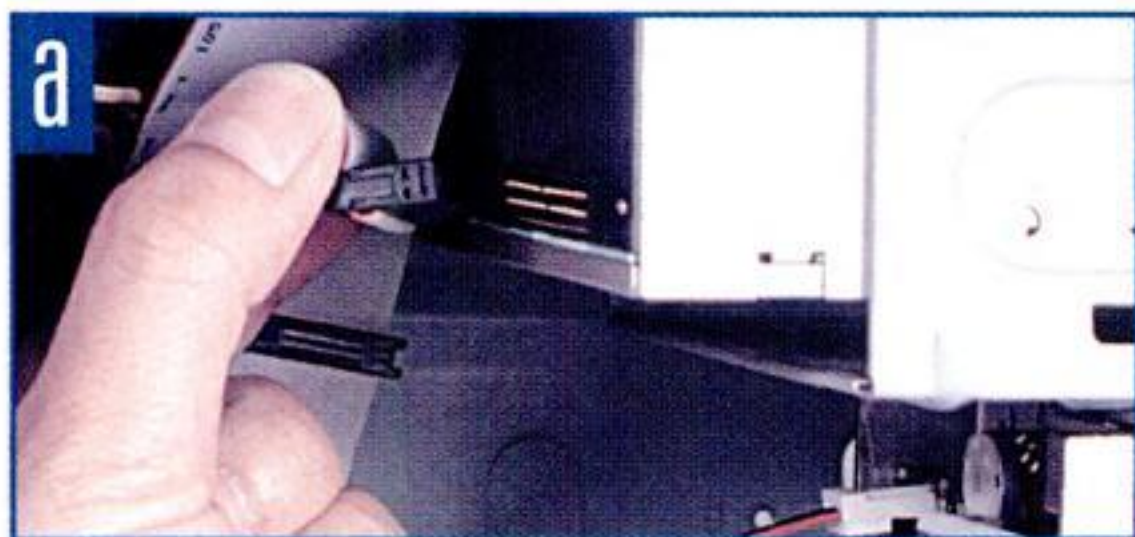


Make sure you plug the ATX power connector to the motherboard in the correct direction. The power plug will usually include a notch that prohibits improper insertion. An incorrectly inserted power plug will kill your PC.

9 Connect Your Drives

It's now time to connect your IDE cables to your optical drives. The cables are notched and should fit only one way into the drives and motherboard. If your case is so cramped that you can't see where the notch is, remember that the red stripe on the IDE cable corresponds with pin 1 on an IDE drive, and pin 1 is the pin closest to the drive's power connector.

After you've hooked up the IDE cables, insert the four-pin power cables to the optical drives. The power cables are keyed so they'll fit in only one way, but we've seen worn-out and cheap power cables that magically fit in the wrong direction. The short lesson is to make sure you have your power plugs facing the right direction.



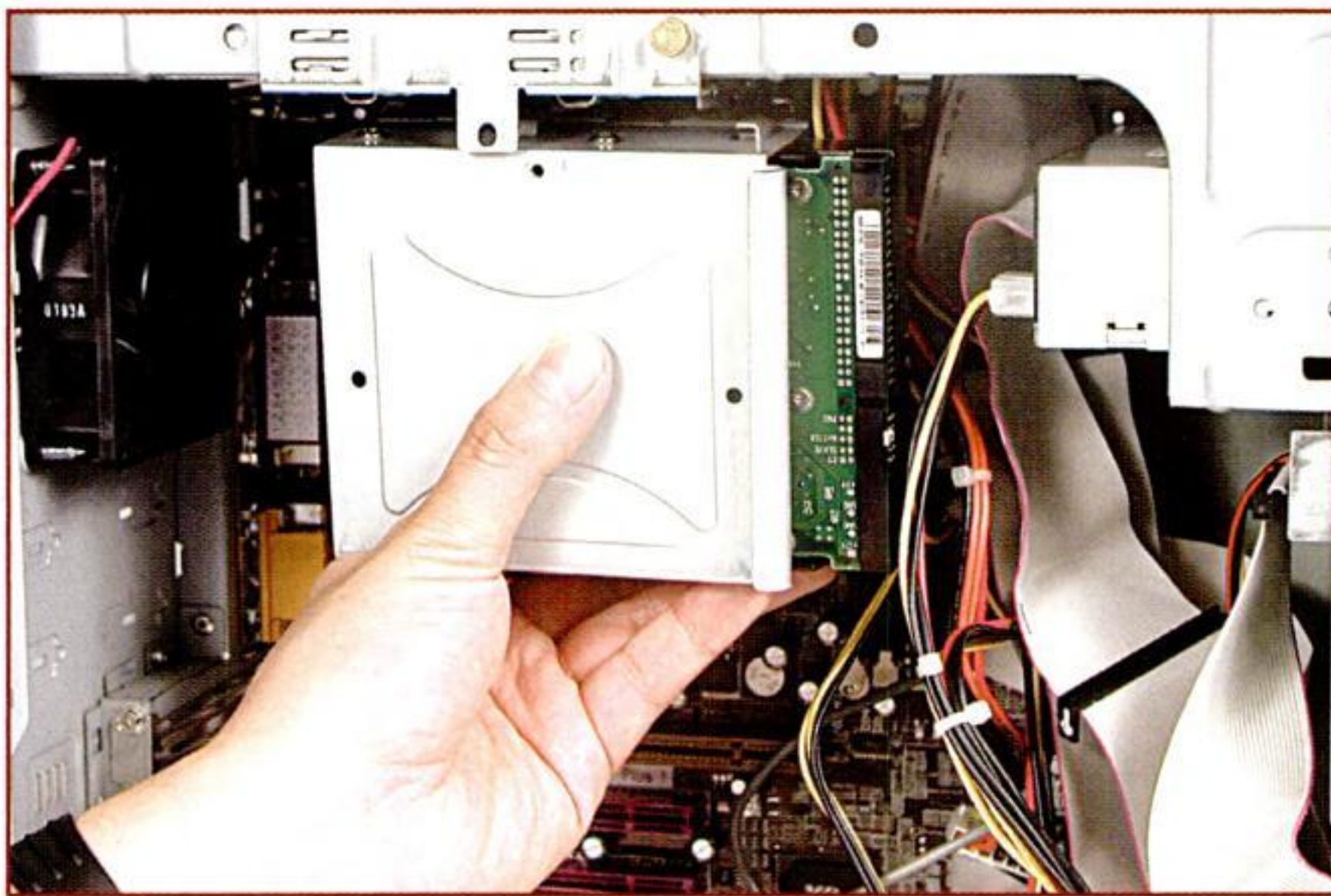
(a) First goes the IDE cable.... (b) Then goes the power connector. For both insertions, be gentle and make sure everything is facing the correct direction.

10 Hook up the Hard Drive

In our PC Power and Cooling mid-tower, we used the included hard drive gondola to mount our hard drive. While the gondola design restricts the use of tall fans and heatsinks, it does aid in cooling the 7200rpm hard drive—because the gondola is more or less suspended in the middle of nowhere, air gets to flow all around it.

If you're not using a gondola, just screw the hard drive into an available 3.5-inch drive bay and remember to leave open space for cooling. Once we screwed our gondola back

into its original position, we hooked up our IDE and power cables, just as we did with our optical drives. Your CD-ROM drive probably doesn't need the dense 80-conductor cables, but all ATA/66 and ATA/100 hard drives do. You can tell the difference between 80- and 40-conductor cables by looking at their wires. 80-conductor cables use very fine wires; 40-conductor cables use relatively thick wires. Because we have four independent IDE channels available, we set the hard drive to master and plugged it into the master interface of the primary IDE controller.



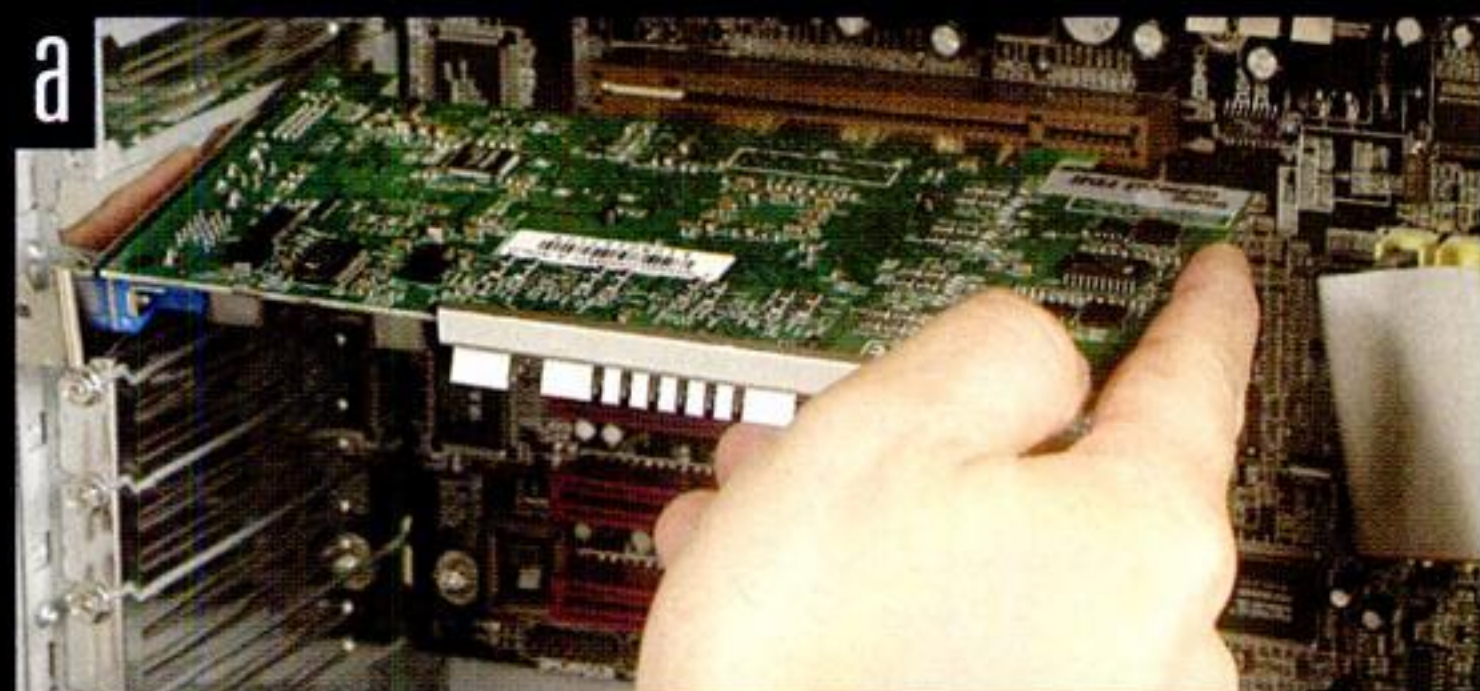
The gondola in our PC Power and Cooling case provides our 7200rpm hard drive with a slightly cooler environment than a drive bay would.

11 Adding the Videocard and the Soundcard

The first add-in card we installed was the Leadtek GeForce3 AGP card. The Soyo Dragon, like many Athlon motherboards, features the slightly longer AGP Pro slot to accommodate cards that need to draw extra power. Our GeForce3 card, however, is a normal AGP card (a). Both the card and slot are keyed so it's near impossible to screw up the insertion of the card—but we have heard of people jamming the card into the wrong slot and frying their systems. If your motherboard has a sticker or small piece of plastic that plugs up part of the slot, leave it in place; this will prevent the card from shifting backward and shorting out.

Back in the day, we would have recommended that you boot your system and verify its health before installing your PCI cards. But because we have so much confidence in today's hardware, we went ahead and also installed a Creative Labs Sound Blaster Audigy soundcard. Because videocards generate so much heat, we placed the Sound Blaster in an open slot away from the AGP card (b).

We're not going to tidy up our wiring until we've "burned in" the PC for a 72-hour period. In fact, you should never, ever, ever put the side back on your case before you boot. If you do, your PC will refuse to boot just to spite you.



12 Set up the BIOS

We've come this far without detecting the acrid smell of charred silicon—so far, so good. Now it's time to set up

your PC's BIOS. The term BIOS stands for "basic input/output system." This is the software that contains all the rudimentary instructions on how your

operating system should communicate with your hardware.

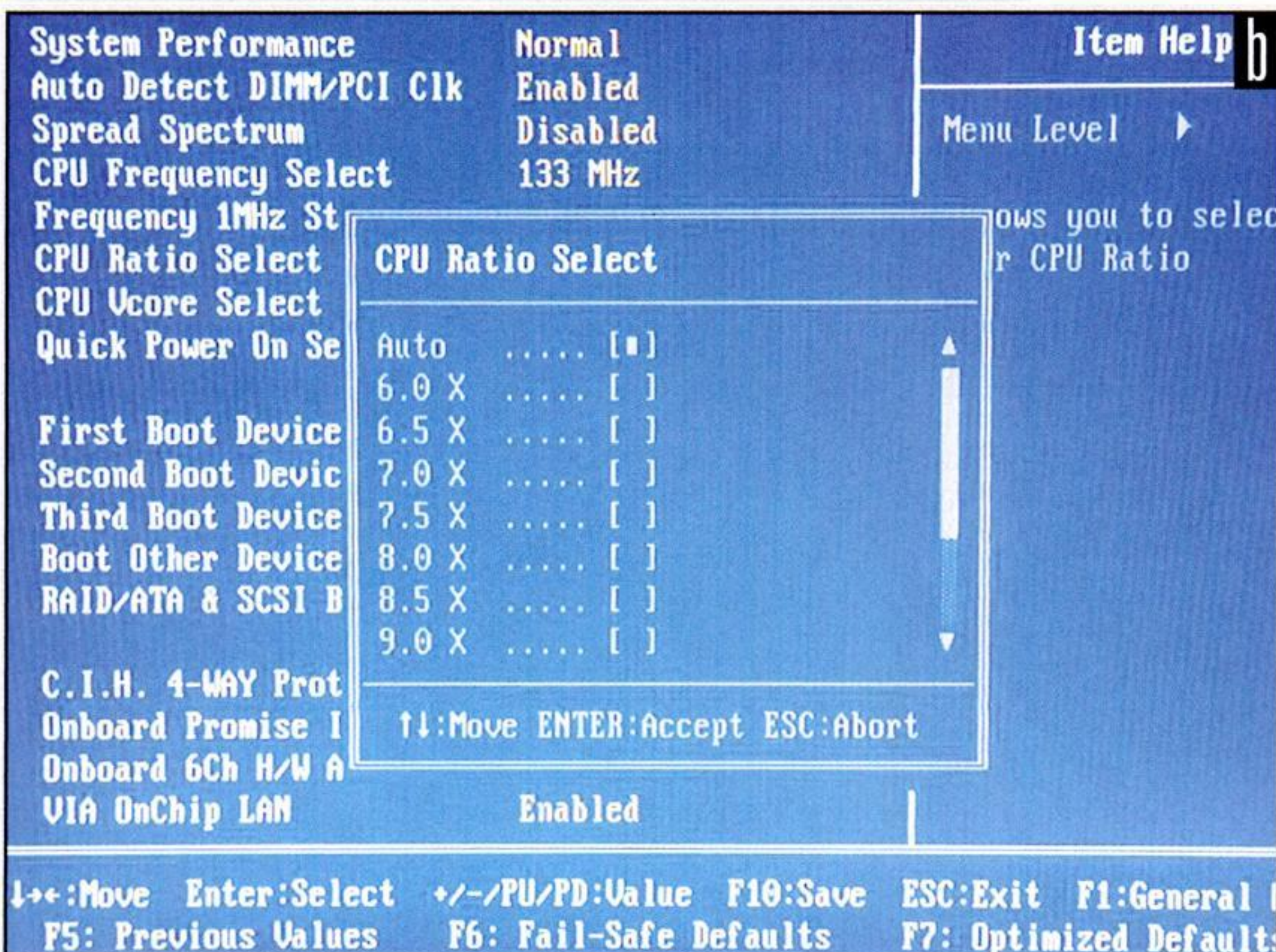
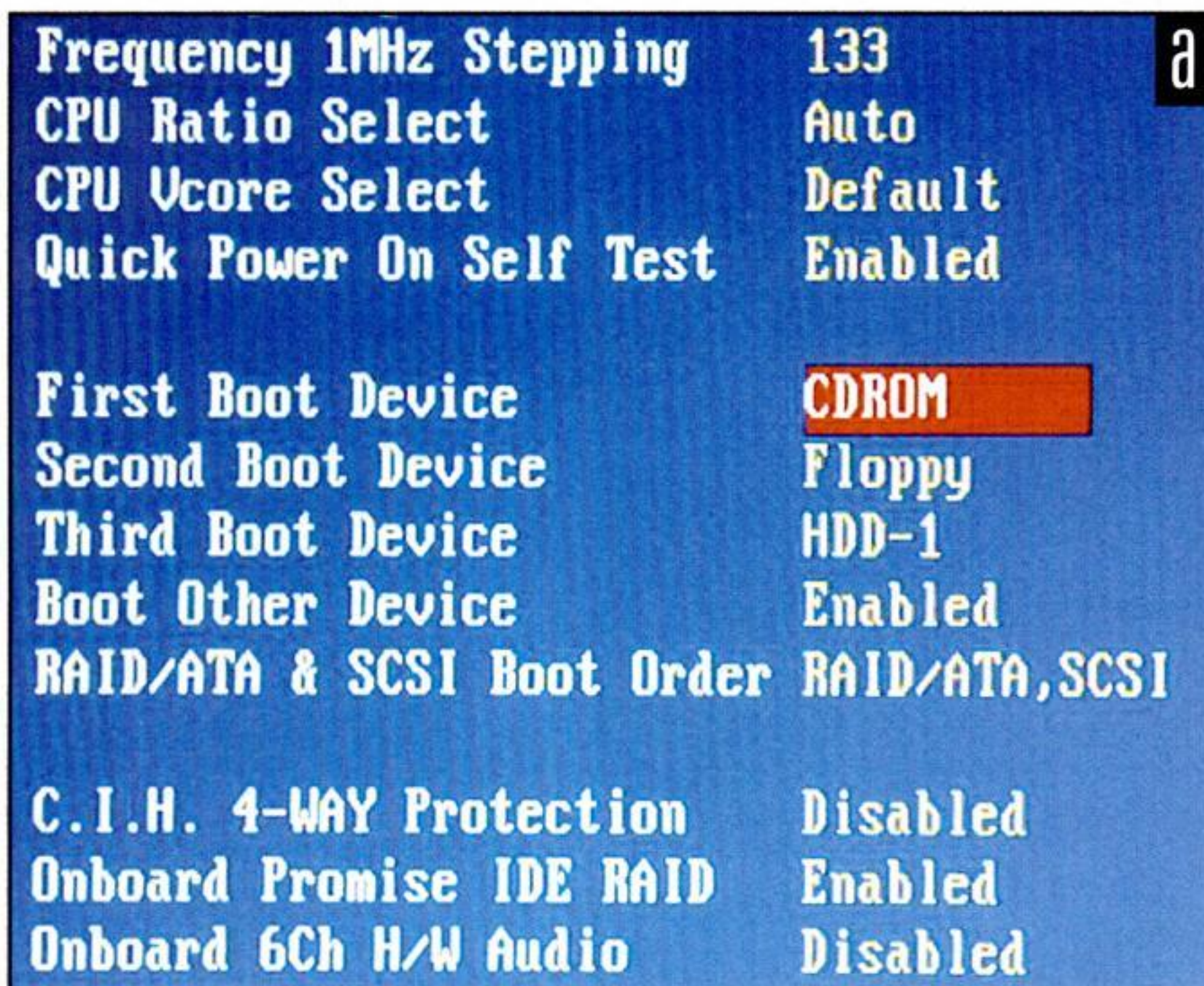
First, turn on your newly constructed PC and punch the key that lets you enter the BIOS. It's normally the F1, F2, or DEL key. If you get a full-screen logo but no key prompt to "enter setup," hit the ESC key. This will spawn your hidden boot sequence. Now you can hit F1, F2, or DEL to enter the BIOS setup screen. Once you're inside the setup menus, you can adjust a number of parameters that will affect OS-hardware communication. But for the purpose of this tutorial, we'll focus on just a few necessities:

■ Because you'll soon be loading Windows XP Home from scratch, directly off its CD, the first thing you'll want to do in the BIOS is set the First Boot Device to the CD-ROM drive (see a). This tells the computer to boot from the CD drive before trying to boot from the hard drive, which is still blank. While you're in the BIOS, you'll also want to disable the onboard audio to make way for the Sound Blaster Audigy card.

■ Make sure your system bus is clocked correctly. For AMD systems, like ours, this means a setting of either 100MHz or 133MHz, depending on the CPU you have—100MHz for Duron and 133MHz

for Athlon XP. Remember that you can't manually set the CPU multiplier (or ratio) for Athlon XP or any Intel processors, so leave the BIOS setting at Auto (see b). If at any place in the BIOS you encounter options for "Maximum" or "Normal," go with the normal setting—you want to make sure everything is working fine before you try to optimize for maximum performance.

■ Check the System Health or Status tab for details on your CPU temperature and CPU fan speed. Our 1.53GHz Athlon XP was running at a mere 111 degrees Fahrenheit, and the fan was turning at about 5500rpm—all within spec.



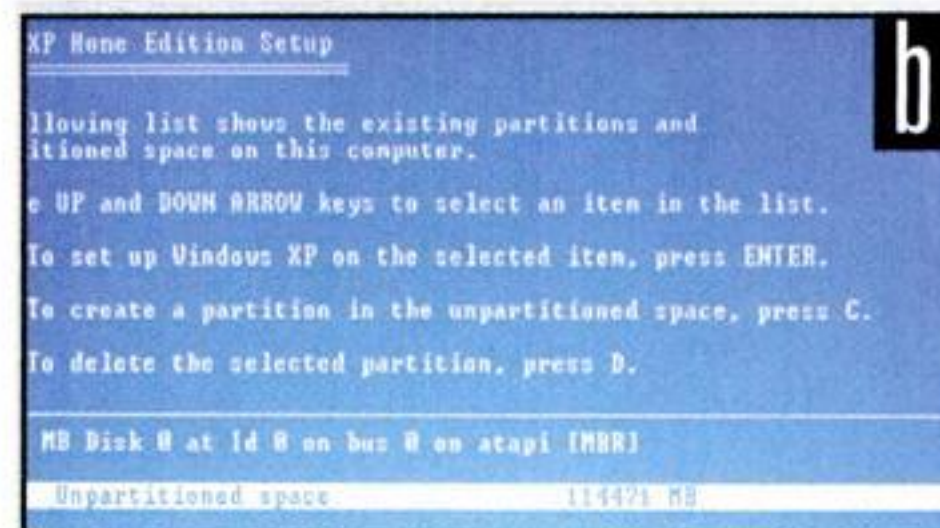
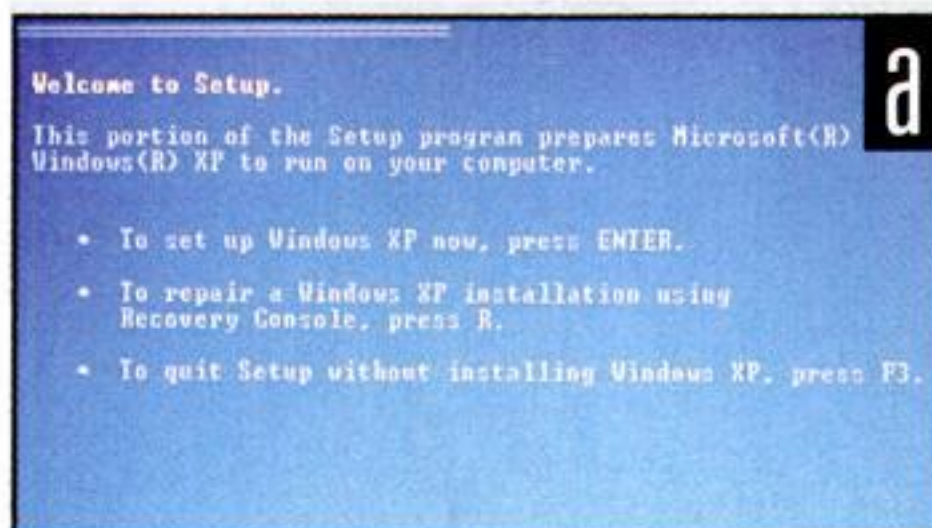
13 Install Windows XP Home

We're in the final stretch, and lucky you, the Windows XP setup routine is much easier than that of earlier versions of Windows.

After following our BIOS instructions, your system should be set to boot from the CD, so insert your WinXP disk and reboot your computer. You should eventually see a screen prompting you to "Press any key to boot from CD," at which point you'll need to press the "any" key.

Before the GUI

After your system has booted off the CD, the installer will start the non-GUI portion of setup (GUI stands for "graphical user interface"). If you want to install Windows on a SCSI drive or RAID array that XP doesn't include built-in drivers for, you'll need to press F6 as soon as you see the blue screen. Otherwise, you can wait for the Welcome screen (a).



Follow the prompts until you get to the partitioning screen (b). Assuming you're using a new hard drive, you'll need to tell Windows how you want to configure your disk. If you're using your old drive, be extra careful at this step—this part of the installer is the WinXP equivalent of *FDISK* and can easily wipe your drive. For maximum performance with XP, we recommend creating one

big partition that spans the entire drive. If you decide you need two partitions later, it's easy to repartition the drive using a utility like *Partition Magic*. Unless you plan on dual-booting Win98 or WinME, we recommend that you use the NTFS format for your new drive. And *always* do a thorough format on a brand-new hard drive!

Once you've started the format, it's usually safe to leave the machine for 20 or 30 minutes. The formatting process is even more mind-bogglingly dull than watching paint dry.

Halfway there!

When you return, your PC should be into the GUI stage of the install. The first screen you'll see is the language options screen (c). Unless you have a nonstandard keyboard layout, or don't live in the U.S., you can safely continue to the next step.

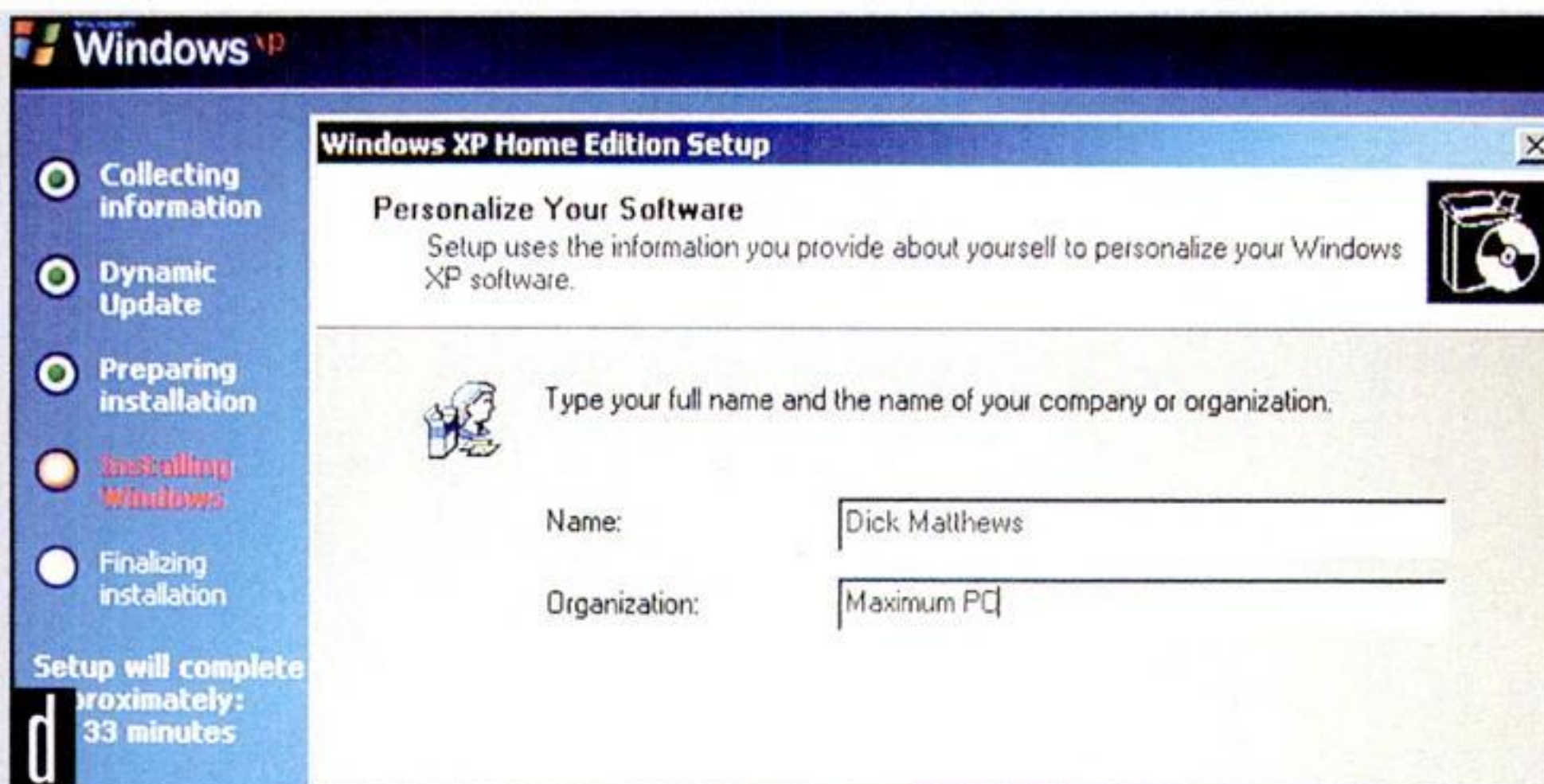
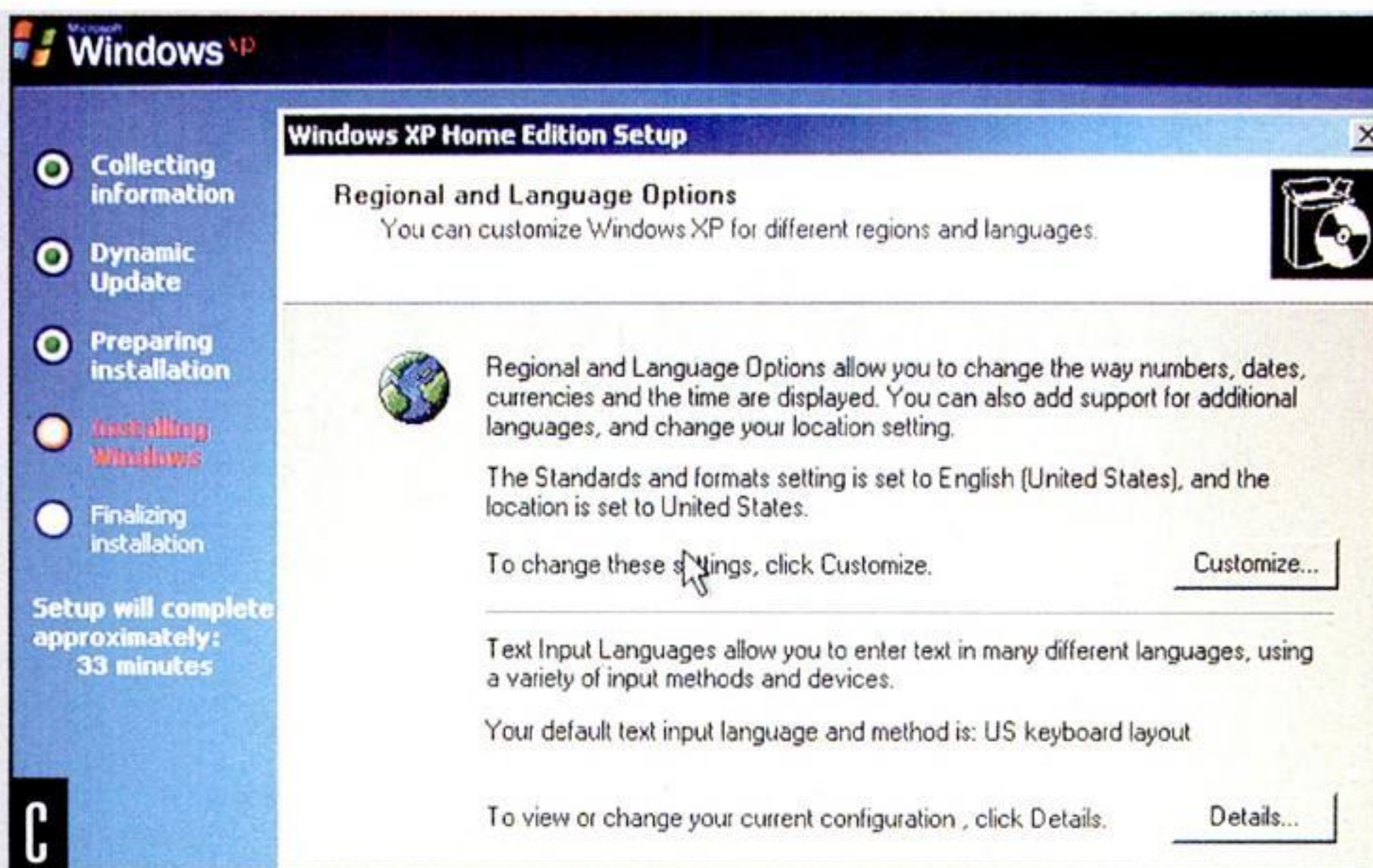
Next, you'll need to enter your name (d). Since we're giving this machine to our friend Dick Matthews, we used his name.

The last major step you have to wade through is the setup of your network. Typical settings work for most cable modems and DSL connections, although you'll need to use manual settings if you have a statically assigned IP address or use some sort of wonky PPPoE connection. After the network is configured, Windows should reboot one last time.

Finishing up

Following the final reboot, you'll be prompted to activate Windows. We recommend that you hold off until you have all the drivers set up for your hardware and everything is working properly. You should have at least 30 days before your unactivated copy of Windows stops working, so take your time.

Now that WinXP is installed, hit the web and grab the latest drivers for your motherboard, 3D accelerator, soundcard, and anything else that might need an update (always install new motherboard drivers first). Finally, have fun with your new system!



Top 10 Troubleshooting Tips

A rogue's gallery of the most common problems that plague new PCs

1 Can't See the Optical

If your PC ignores the CD-ROM during the boot process, preventing you from booting off the Windows XP disc in the drive, double-check the boot sequence in the BIOS. The BIOS is a set of all the hard-coded instructions and drivers needed to start your PC before other software—namely, your OS—can take over. It's easy to get into the BIOS. With most motherboards, you can enter the BIOS by hitting the F1, F2, or Delete key during the initial boot sequence. If the onscreen instructions indicating which key to press go by too quickly, just press the Pause key.

Once you're in the BIOS, you'll need to find a menu or menu option called "Boot Device Priority." This is where you establish the order in which your PC turns to different components looking for an OS. Make sure CD-ROM is designated as the first boot device. After you're finished installing the OS, you can speed up future boot times by making the hard drive your first boot device.

2 Mayday, Mayday!

Sometimes your PC simply won't boot at all, and only emits a series of beeps from your PC speaker. This is called a POST, or "power on self test," error, and it means that a component crucial to booting (like a videocard or hard drive) is broken, improperly seated, or improperly configured.

The sequence of beeps you hear isn't random. The number and/or length of the beeps describe the nature of the problem. For instance, two beeps on a motherboard that uses an AMI-manufactured BIOS means there's something amiss with your RAM modules.

Your motherboard's manual will help you decode the sequence of beeps for troubleshooting.

3 Sound Off

If your system powers up, but won't boot and doesn't elicit any beeps, make sure you have your case speaker connected to the motherboard; you'll want to hear any error messages that the system might issue. Some motherboards come with their own onboard speakers, precluding the need to connect a case speaker.

4 Code Red

If your system doesn't respond at all when you press the power button—no whirring of fans, no beeps, no nothing—don't panic. The first thing to do is make sure it's plugged in. No need to be embarrassed—it still happens to us on occasion. Make sure the plug is firmly inserted into the power supply as well as the outlet. If you're using a UPS (uninterruptible power supply), make sure that's plugged in too. If that doesn't do the trick, reseal the graphics card, RAM, and any PCI cards you've connected, and then make sure the motherboard power connector is firmly plugged in. Take it out, and reattach it.

5 Exile the Riffraff

It's always possible you were sold a bum part that's preventing your PC from booting, or that you're using a fully functioning part that's saddled with broken drivers. To determine if this is the problem, follow this most basic of troubleshooting methods: the process of elimination. Working backwards from the order in which you installed the cards and/or drivers, remove a card or driver, and try rebooting. If that doesn't work, replace the component and/or driver, and try removing the next part down the line.

If you've got a replacement part that you know is healthy, like an older network card that you're replacing with a new wireless card, try swapping that and rebooting.

It takes patience, but eventually you'll find the driver or subsystem that's giving you trouble.

6 Drive on the Left Side

PC power supplies support both the 115-volt power used in the U.S. and the 230-volt power used in other parts of the globe. Most power supplies are already set to 115, but we have occasionally seen them set to 230. Make sure your supply is set properly before you fire it up. This problem is rare, but when it happens, it stumps even the pros.

7 Hot Flashes

If your system starts up fine but reboots after a few seconds, it's likely you have an overheating problem. Your heatsink may be inadequate for your CPU, or you may have forgotten to install the ther-

mal pad or thermal compound between the CPU and heatsink. If you have indeed applied the pad or compound properly, make sure your CPU/heatsink fan is connected to the motherboard headers for power. If it does work, you may have to upgrade to more advanced cooling paraphernalia (see page 74 for more information on this subject). Also, make sure your CPU is clocked within its specified range.

Lights On

8 If the floppy drive refuses to work and the access light stays lit, then the cable was attached incorrectly (this is very common, because there isn't any notch or block to prevent the cable from being installed the wrong way). Power down the system, and simply flip the cable over on the floppy end of the chain.

Disappearing Drives

9 If your PC can't detect your hard drive, the first thing to do is completely power off the PC, reseal the IDE cables on both ends, and power back on. If you've got more than one hard drive, and your PC can't see either of them, double-check their master/slave settings. Each IDE channel can support two drives: one master, and one slave. The drive that will house the OS should be set to master, and the other drive set as slave. These settings are determined by moving a jumper next to the IDE

connector on the drive itself. On most drive labels, you will find a diagram that indicates jumper placements for master and slave designations, but sometimes you'll have to refer to the documentation for instructions.

If your PC can't see your hard drive and your motherboard comes with built-in IDE RAID, make sure your jumper settings or BIOS are properly configured. Check your documentation to determine how to switch between RAID and Ultra DMA settings, depending on which you are using.

Underclocked CPU

10 The initial boot screen should post your CPU's speed (although with Athlon XP CPUs, you won't get the clock speed, but rather AMD's "performance rating"). If it's lower than you expected, the frontside bus speed is probably underclocked. On a Pentium 4 motherboard, the frontside bus will run at either 400MHz, 533MHz, or 800MHz. On an Athlon XP motherboard, it will be either 133MHz, 166MHz, or 200MHz. Make sure you know what frontside bus your CPU supports before you clock it up.

Most modern motherboards allow you to set the frontside bus in the BIOS, while others require that you configure jumpers on the board's surface for the correct speed. Your motherboard manual will tell all.

Safety Tips

An ounce of prevention is worth a pound of fried hardware—five crucial safety tips for PC builders



Unplug the Power Supply!

Don't work on your PC with the power supply still plugged into the wall. Even when the PC is off, the power supply transmits a small amount of electricity to the motherboard, and removing components with the PC still plugged in could fry them.



Static Be Gone!

Static electricity can, and does, kill computer components. So pick up a cheap antistatic strap at the local electronics store, and make sure it's connected to something grounded. Don't start your

building project on the shag carpet of your living room, and for God's sake, don't build the PC while dressed in a polyester leisure suit. At the very least, touch your PC's power supply, or some type of metal object that's grounded, before working on your PC.



Clean the Sink!

Today's high-performance heatsinks and CPUs need to be in firm contact with each other to dissipate heat properly. If they're not, your CPU can crack. If you're reusing an old heatsink, make sure you use rubbing alcohol to thoroughly clean off the old thermal goop, and apply just enough thermal compound to cover the core. Don't apply so much that it oozes out and shorts contacts.



Be an AGP Pro!

When inserting a regular AGP card into an AGP Pro socket, make sure you don't hammer the card into the wrong part of the socket, as it may short out your mobo or videocard. Most AGP Pro sockets have safety tabs to keep the card from being inserted incorrectly, so don't remove these tabs unless you absolutely need to.



Insert Your Cable Slowly!

As with any cable connector, be especially careful when inserting the flat IDE cable into your hard drive or optical drive. If the cable doesn't have a safety tab that prevents it from being put in upside down, you can easily destroy a pin—or two or three or four—on your brand new 200GB hard drive.

The 10 Tenets of Effective Case Cooling

Don't let your 2GHz PC turn into a four-alarm fire!

When their circuit counts are combined, the Athlon XP CPU and GeForce3 graphics processor account for more than 90 million transistors—and every single one of those transistors gets hot, hot, hot when under duress. Worried about heat stroke? You should be. So before you put your PC together, develop a cooling strategy to prevent a serious meltdown. Here are the 10 most important things to consider when contemplating meltdown-prevention. If you follow these tips—and don't overclock your parts—you should never run into problems.

1 Front to back, top to bottom

Your rig's airflow should be the same regardless of the number, shape, and size of your fans. Air should come in at the bottom of the case and be blown toward the back. It should then be sucked up and out the top of the system. To this end, fans at the front and bottom of your case should draw air into the case, while fans at the back and

top of the case should blow air out. This includes blowhole fans, drive bay fans, and PCI slot fans.

2 Keep a clear path

When you design the cooling scheme for your case, make absolutely certain you maintain a nice "jet stream" through your case's interior. This essentially means removing unnecessary obstructions. Using cable ties to reduce the clutter of IDE and floppy cables can dramatically improve your cooling.

3 Basic cooling precedes exotica

Before you add a heat pipe or peltier cooler in order to overclock your CPU, devise a good cooling layout based on a normal system bus speed and rudimentary case fans. If your rig doesn't behave properly with basic cooling, it probably won't appreciate being overclocked with exotic cooling.

4 Know what's hot and what's not

Take advantage of the temperature monitors that are built into your motherboard, but don't rely on them exclusively. To this end, you should pick up a good electronic wired thermometer at your local Radio Shack. Attach its probe to a suspect area of your case interior, close the case's side panel, run the PC for a few hours, then check the probe's digital readout. Record the temperature, then move the probe to a new location. Repeat this procedure for different parts of your case—if you find any hot spots, consider additional cooling for those areas.

5 Optimize airflow!

A good way to perfect your system's flow (assuming you have a sufficient number of fans) is to use clear packing tape to seal any extra case holes, or cool air will leak from the back of your PCI slots before it can run over your CPU and memory. Also ensure

DANGER!

Edmar Dominicci sent us this grim example of what happens when you fail to plug in your heatsink's fan.



that you have an equal number of fans blowing air into and out of your system. You don't want to have more air coming in than going out, and you don't want to create a vacuum inside either.

6 Use a filter over your intake fans

Dust kills PCs, so grab some "filter media" to protect your computer. It's the same stuff that filters air going into your house's central air system, and most hardware stores stock it (but you'll need to cut it to the proper size). Electrostatic filters grab more dust, so they're preferable. Just remember to clean out your filter every month or two!

7 Hot, hotter, hottest

In most systems, the CPU is the hottest component, followed by the videocard, the motherboard's core-logic chipset, the memory, and finally the hard drives. Don't neglect any of these components, but remember to make cooling the CPU and videocard a priority.

8 Keep your hard drives cool

High-speed hard drives—such as the 7200rpm beasts that are common today—generate a lot of heat. Make sure you have sufficient air flowing over them to increase their lifespan.

9 Don't overstress your mobo

Don't plug massive dual fans into your motherboard fan headers. Those headers are designed to power a single 8cm fan, not three 10cm fans.

10 Get the right fan/heatsink combo

If a reseller sold you an AMD processor that didn't come with a companion heatsink and/or fan already attached, go to www1.amd.com/products/athlon/thermals for a list of "thermal solutions" recommended by AMD for its entire line-up of CPUs.

Intel doesn't have an equivalent table on its web site, but it does have voluminous notes on thermal management for its CPUs; go to support.intel.com/support/processors. When you buy a fan/heatsink combo for your Intel processor, make sure it is specifically designed for your type of proc. ■



Thermaltake's Volcano 7 fan is a heavy-duty fever-reducer for today's monster CPUs.



He disappeared five days ago.
He's gotta be on Level 928 by now.



He had good grades. Nice parents. A bright future. But then he built a mind-altering gaming machine and escaped to a different reality. A reality where victory is vastly more important than piddling distractions like sleep, food, or 'the real world.' Good thing he's got an Antec gaming case in his arsenal. Take our new P160 and Super LANBOY, for example. Carved from supremely strong anodized aluminum, our gaming cases boast a drool-inducing array of features. Like ten drive bays and a swiveling control panel on the P160. Or nine drive bays and a clear side window on the effortlessly portable Super LANBOY. So get an Antec gaming case. And escape to a more stimulating reality. Now that's *the Power of You*. To view our full line of products, visit www.antec-inc.com.



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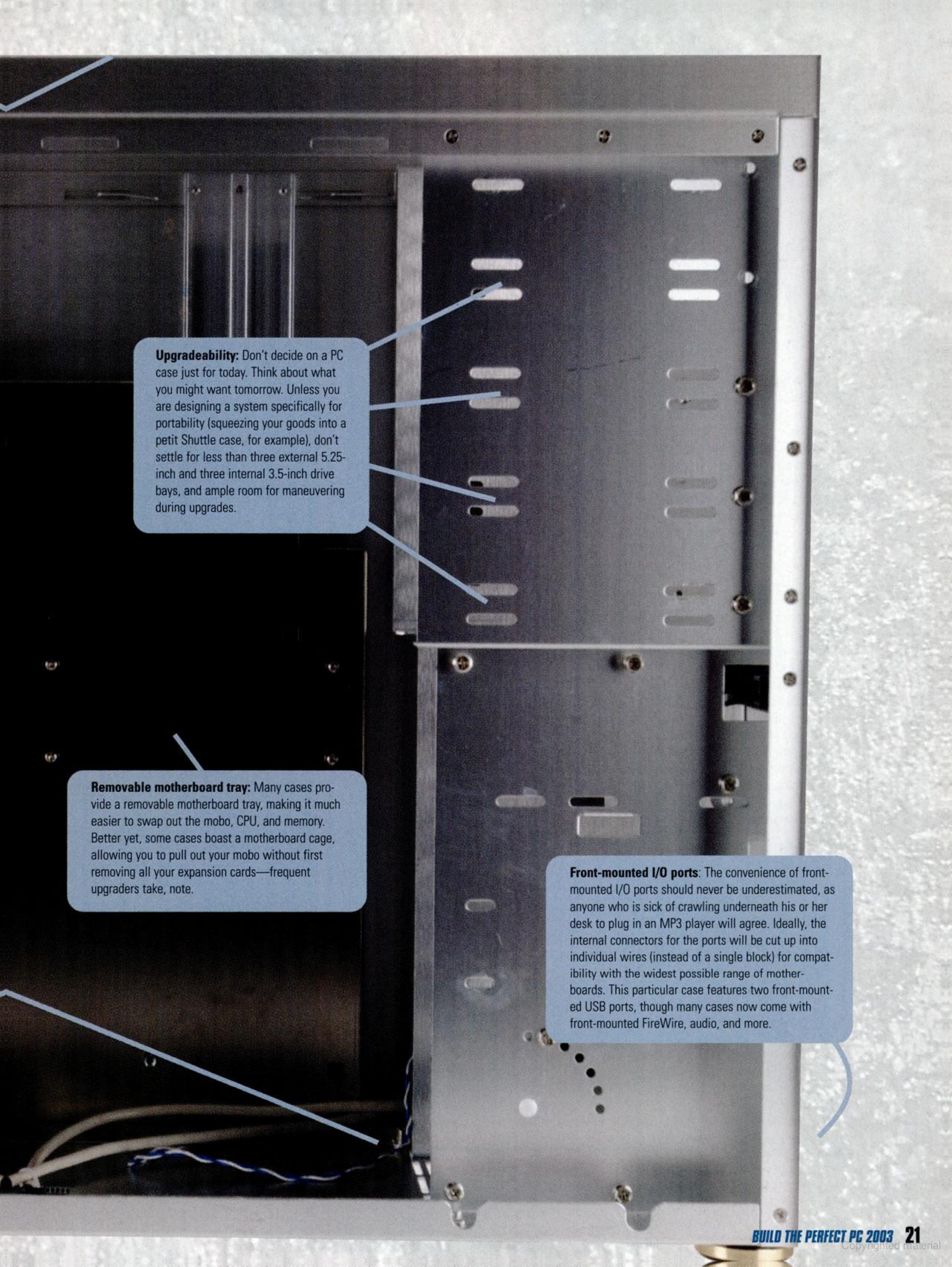
J&R

CASE

Build quality: If you don't intend on stacking components on top of your PC, the strength of your case probably isn't of paramount concern. But keep in mind that a hefty case made of steel or thick aluminum doesn't just prevent crumpling if your super-sized friend takes a breather on it—it also helps dampen the noise from your components.

You should also be on the lookout for details such as folded or blunted edges in the interior. It doesn't seem important until you've had some of the truly gross experiences we've had inside cases with sharp, burled edges.

Cooling features: A well-designed case will allow good airflow, with adequate ventilation and plenty of mounts for cooling fans in strategic locations. The ideal case will also include several cooling fans. This particular case includes three fans, one of which is a tilted front intake fan cleverly positioned to pull in cool air from vents in the floor of the case. And please don't block the intake fans by placing them against walls or barricading them with peripherals!



Upgradeability: Don't decide on a PC case just for today. Think about what you might want tomorrow. Unless you are designing a system specifically for portability (squeezing your goods into a petit Shuttle case, for example), don't settle for less than three external 5.25-inch and three internal 3.5-inch drive bays, and ample room for maneuvering during upgrades.

Removable motherboard tray: Many cases provide a removable motherboard tray, making it much easier to swap out the mobo, CPU, and memory. Better yet, some cases boast a motherboard cage, allowing you to pull out your mobo without first removing all your expansion cards—frequent upgraders take note.

Front-mounted I/O ports: The convenience of front-mounted I/O ports should never be underestimated, as anyone who is sick of crawling underneath his or her desk to plug in an MP3 player will agree. Ideally, the internal connectors for the ports will be cut up into individual wires (instead of a single block) for compatibility with the widest possible range of motherboards. This particular case features two front-mounted USB ports, though many cases now come with front-mounted FireWire, audio, and more.

How To Pick the **BEST** CASE

Finding the ideal habitat for your components

We've lost track of how many times we've espoused the importance of choosing a quality case, but it's time for a recap. A case is more than just a shoebox for your components. A good case improves the stability of your system by channeling punishing heat away from your parts. It can reduce noise by stabilizing noisemakers such as optical drives and side-panels that resonate. A well-thought-out case makes using your PC more convenient by trundling vital connections like USB and FireWire to the front. And last, but definitely not least, a good case looks *cool*.

While choosing a case is one of the most important decisions you'll make when designing a PC, it can also be one of the most vexing. There are literally hundreds of cases from various manufacturers vying for your attention, all claiming to be the best of the best. Even the hardest geek would tire of sorting through all the riffraff, but hey, that's why we're here. We've broken down all the important attributes you should look for when choosing a case, and included reviews from our monthly magazine of some of the best cases we've seen recently. So if you're ready to begin your search for the perfect case, let's get started!

BASIC STRUCTURAL DESIGN

The first thing you need to establish before buying a case is whether portability is an important factor. If you often tote your rig to friends' houses or LAN parties, you'll want a smaller, more lightweight case. If portability is paramount, you'll want a mini-case like the one pictured on this page. But for a PC that's going to stay put, we strongly recommend choosing a case that's relatively large—this will improve airflow and give you more room for upgrades.

In any event, the case is bound to be pushed around now and then, so you'll want to consider sturdiness. Steel cases tend to be more rigid, while aluminum cases are generally more flimsy. You should also check out the thickness of a case's material—if it seems no thicker than a Coke can, it's probably no

stronger either. Try pushing down firmly on the top of the case when it's fully closed. Any give is a bad sign. You wouldn't think that a case could be *that* fragile, but we've seen a few that are. Lastly, to avoid any undue trips to the emergency room, make sure that any rough metal edges on the interior of the case have been folded over to protect your fingers—you'd be surprised how many cases have carnivorous interiors.

THOUGHTFUL AMENITIES

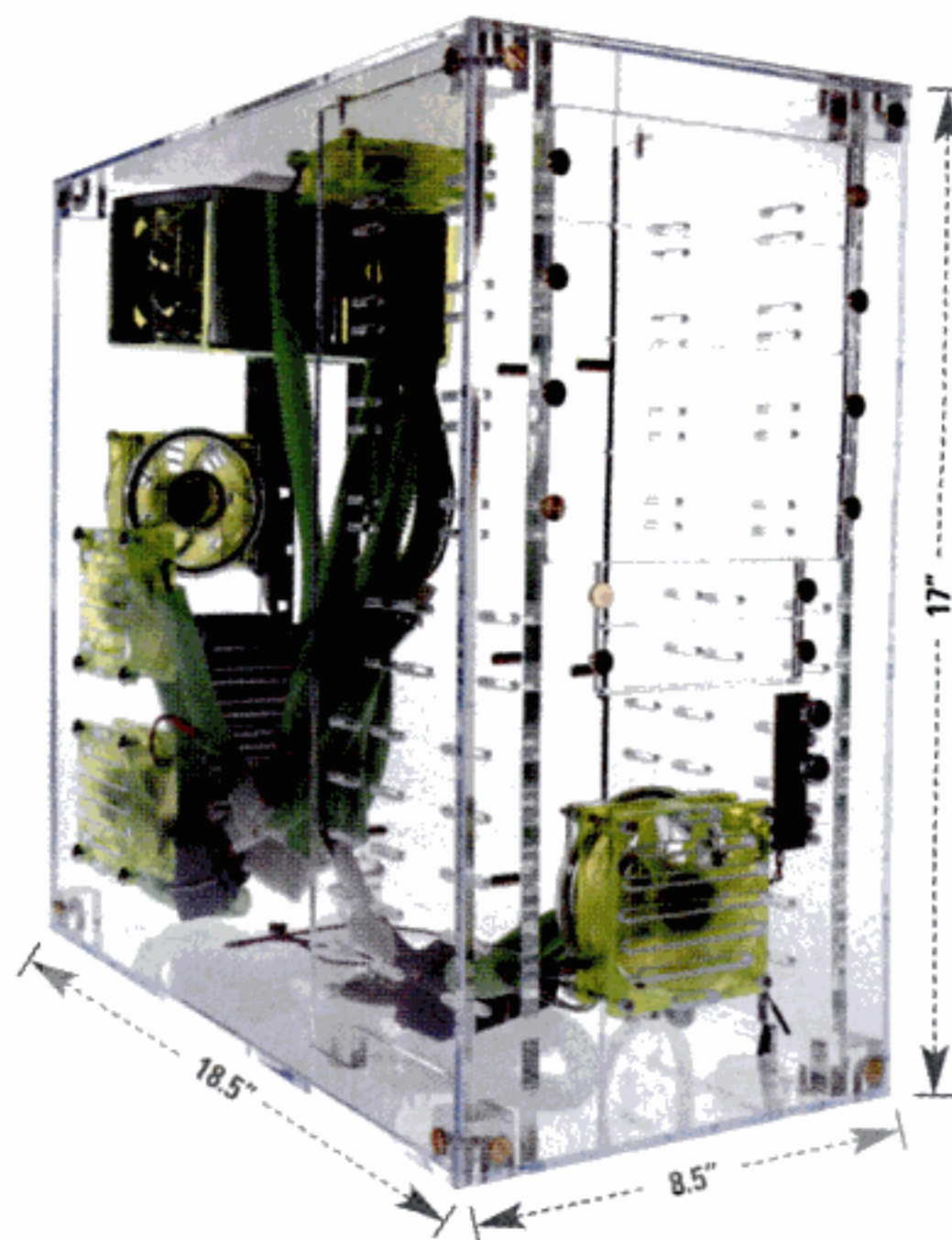
Planning the interior of your case and installing all your components doesn't have to be a chore. A well-designed case can make the process easy. Seek out a case with enough ventilation holes and strategically positioned fan mounts to keep all your piping-hot components running cool. At the very least, you'll want mounts for front intake and rear exhaust fans; ideally, you should have cool air blowing across your CPU, videocard, and hard drives, as these are the hottest-running components in your system. Some particularly well-thought-out cases even include filters for those vents to help keep out unwelcome dust particles. Premium cases will include wire guides and clips to help you tidy up your PC's internal wiring. Although these features can dramatically reduce internal temperatures, they remain pathetically uncommon.

If you do a lot of upgrading and drive-swapping, look for a case that features thumbscrews for the side panels and expansion slots (thumbscrews don't require a screwdriver every time you want to peek into the works). A case with drive rails—a locking system that lets you pull drives in and out of your system without screwing and unscrewing them every time—will make drive-swapping a snap. One caveat: Given the high speeds that hard drives and optical

drives spin at these days, it's absolutely critical to make sure that a drive-rail system is well-designed and sturdily constructed. Make sure you can return the case from where it was purchased without a restocking penalty if you find the drive rails don't fit snugly enough to prevent rattle.

For those who are tired of listening to a PC that sounds like a vacuum cleaner, this may come as music to your ears: Some manufacturers are now offering cases specifically geared toward a quieter computing experience. In these cases, look for features such as rubber grommets on the hard drive mounts (to absorb vibration and noise), bundled-in fans that are quiet and preferably speed-adjustable, and a sturdy construction that helps dampen noise rather than amplify it. This is the kind of thing you may only be able to evaluate after you've bought the case, so make sure you can return it without penalty if it's a dud.

Nothing elicits more swearing from *Maximum PC* staffers than having to crawl around to the back of a PC just to plug in an external device. Front-mounted I/O ports will spare you pitched battles with dust and roaches every time you want to plug in your USB key. Almost every case comes with front-mounted USB ports these days, and some even come with front-mounted FireWire and audio ports. Internally, you'll need to connect these ports to the



Xoxide's UV-reactive case glows under ultraviolet light, illustrating just how crazy you can get with your case if you're game.

appropriate headers on your motherboard. Headers are groups of pins used to hook up devices and I/O ports to your mobo, and the arrangement of these pins varies from motherboard to motherboard. As such, you should look for a case that has its USB and FireWire connectors cut up into individual leads that can be connected in any order, as opposed to a fixed block of leads that may be incompatible with your mobo. Or if you prefer, some cases feature pass-through connectors for their front-mounted I/O ports that simply hook up to the appropriate ports on the back of your system.

LEAVE ROOM FOR IMPROVEMENTS

Any case that can be opened without an engineering degree could be advertised as having "easy access." But the devil's in the details. An upgrade-friendly case should be large enough to hold all your existing components comfortably, as well as any components you think you might purchase in the future. The case should also be easy to work on—features such as drive rails, removable drive cages, and particularly a removable motherboard cage or tray are optimal.

Finally, the ideal case will accommodate a variety of motherboard sizes. If you're interested in running a dual-processor rig, for example, make sure your case can fit a full-size ATX motherboard (few can).

BODY MODS

How do you know when a once-underground craze like case modifying has truly gone mainstream? When your local computer store starts to carry a staggering array of pre-modded cases, all mass-produced and ready for purchase. Many manufacturers now offer enclosures that come complete with side-panel windows, neon-colored LEDs, and even sound-sensitive cold-cathode lights. Some companies also offer their cases in a variety of slick color schemes. That means you can now own a trick-looking rig without the dangers of using a Dremel tool.

Of course, if you're the do-it-

yourself type, you may want to bust out that Dremel anyway and do your own custom case-modding job. If that piques your interest, look for a case that facilitates easy modding. A case with thin side panels, or at least panels that aren't particularly thick, is probably best. But at the very least, make sure you get a metal case—cutting holes in a plastic case is almost impossible, and it sure as hell won't be pretty.

BUNDLED-IN EXTRAS

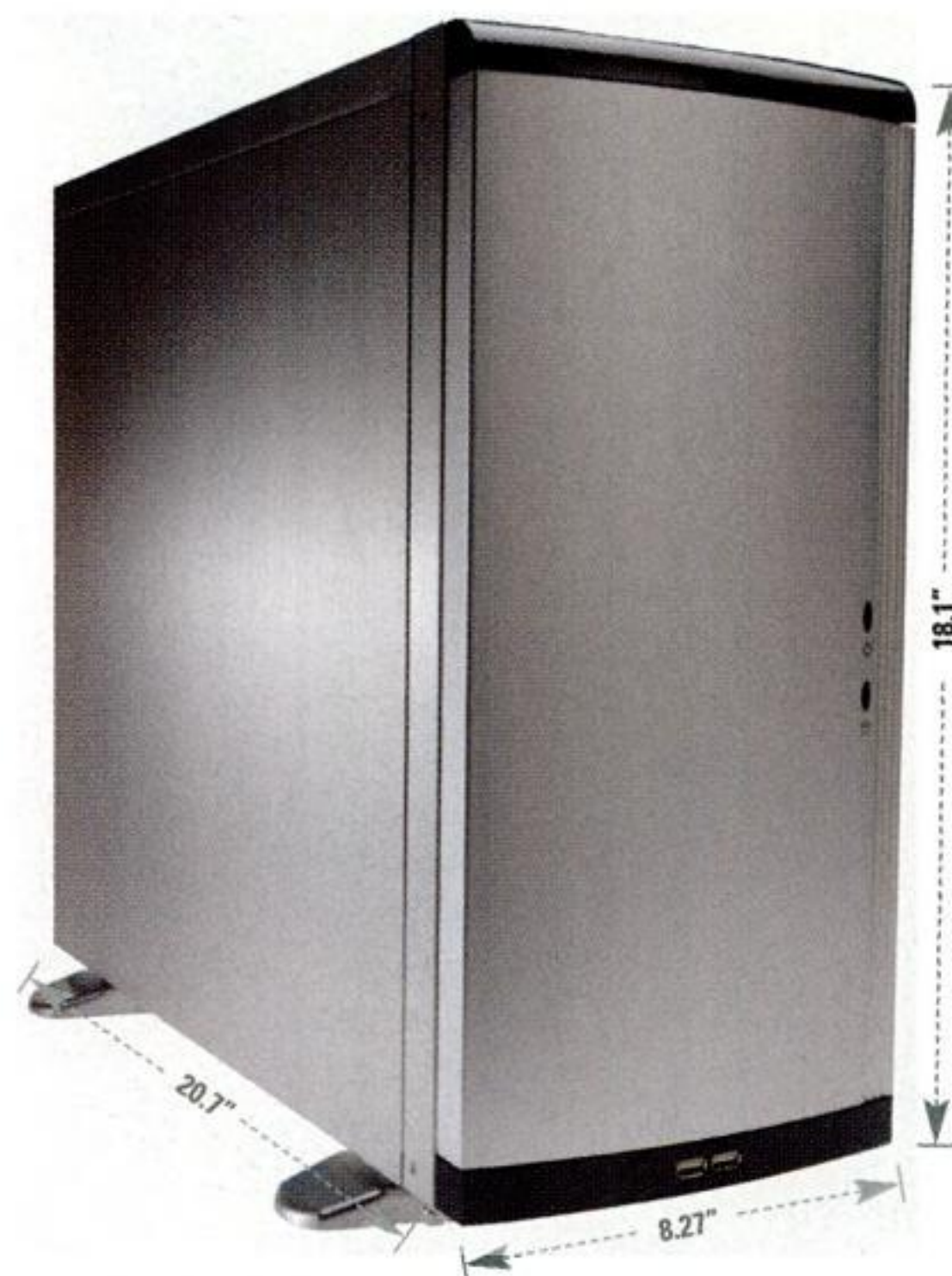
To differentiate their products from the masses of me-too offerings, some manufacturers bundle extra goodies with their cases. Case fans are perhaps the most commonly bundled extras; almost every case comes with at least one. Ideally, the included fans will be temperature-sensing, speed-adjustable, or at least quiet. Some case manufacturers include fans with bright neon LEDs, which look slick when viewed through a window. You may want to spring a few extra bucks for a case that comes with a fanbus to control the speed of your fans, such as Thermaltake's Xaser III.

Power supplies are also commonly bundled with cases, but most of the time, they're cheap throwaway units. Try to find a case that bundles a quality power supply if possible, as this can be a real money saver (see our article on page 71 about how to identify a high-quality power supply). If the case you buy comes with a crappy no-name unit, we highly—*highly*—recommend buying your own add-in power supply.

Another extra you might want to look for in a case is a temperature sensor with an overheating alarm and an LCD readout on the front of the case. And if you move your system a lot, a carrying strap could prove invaluable—yes, believe it or not, some manufacturers are now bundling carrying straps with their cases!

APPEARANCE AND PRICE

Appearance is a highly subjective thing, so we can't really give you any advice other than to get a case that is aesthetically pleasing to



Lian Li's PC-6070A has noise-absorbing foam, a soft rubber seal around the front door, and three nearly silent 80mm case fans.

your own eyes. There are plenty of cases out there that strike a balance between form and function, so you don't need to sacrifice good looks to get a case with all the features you want.

Be forewarned that when you find the perfect case with all the features you're looking for, it prob-



If you've found the "almost perfect" case, don't forget you can make up for its shortcomings with mods of your own. The Enermax A07FATR2, for example, adds front-mounted I/O and temperature monitors among other things to your PC.

ably won't come cheap. So be prepared to spend a fair chunk of change on your case, and know that it's a worthwhile investment.

Now that you know what to look for in a case, let's take a look at some examples of quality cases. Turn the page to check out reviews of some of the best cases that have passed through our lab recently.

top picks

Thermaltake Xaser III

For extreme upgraders, Thermaltake offers the Xaser III, which sports no fewer than seven 80mm fans. On top of that, the Xaser III has an integrated baybus featuring four knobs for fan-speed

adjustment (each knob controls two fans, which can be turned up or down in a continuous fashion). You can precisely monitor interior temperatures via an integrated LCD display on the baybus, and the system will even trip an alarm should the interior overheat.

Construction is all-aluminum except for a few minor plastic parts, and the side window is optional. There are four 5.25-inch and two 3.5-inch front accessible bays, as well as an additional six internal 3.5-inch bays. A familiar rail system is ready for drive mounting, and Thermaltake includes internal storage racks for unused rails, so they won't be misplaced. There's also an "intrusion switch"

that can warn you when someone tries to get to your rig's insides.

We would never call a \$198 enclosure "low cost," but the Xaser III is a lot of case for the money.



Antec LANBOY

The LANBOY offers a cunning mix of practicality and aggression. Four 5.25-inch railed drive bays and two 3.5-inch external bays hide behind a plastic, faux-silver door. The case also features two internal 3.5-inch bays. The cooling configuration is minimal: There's room for a single 80mm fan in front, and another in the rear exhaust position.

For pimp and swagger, the LANBOY includes a 350-watt SmartBlue LED power supply, which casts a nice glow off your components when viewed through the included case window. Two front-mounted USB ports put to rest any notion that the LANBOY is a barren package.

The LANBOY might be polished and feature-laden, but it's no hog. Standing at 17 inches high, the full-featured case doesn't take up much room, and the LANBOY's light aluminum construction allows for swift deployment, especially when you use the included case carrier.

Unfortunately, the LANBOY's weight-saving design sacrifices the sturdiness of a hefty steel case. The mobo tray isn't removable, but we loved the included screw compartment—super-handy when swapping hardware in the field. We also dig the locking tray cover, which keeps unauthorized swapping from occurring at all.

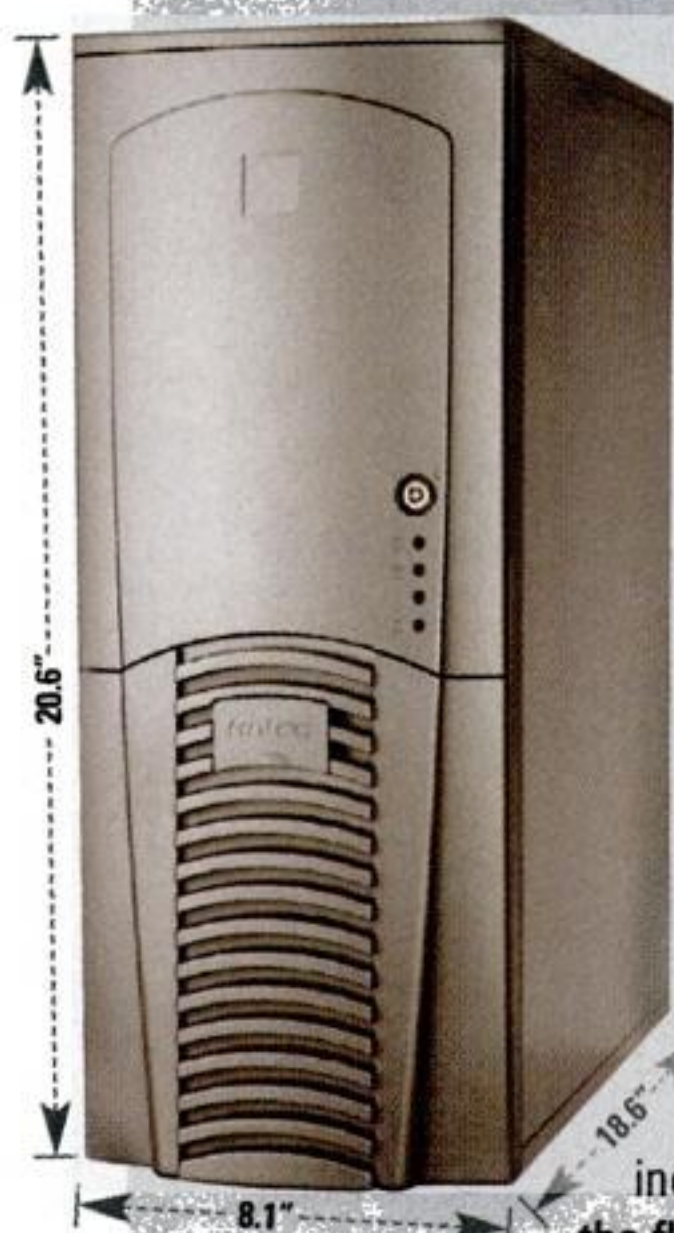


Antec PLUS1080AMG

One of this tower's best attributes is its industrial-strength construction—you can sit on the 1mm-thick galvanized steel without squashing it like a tin can. Cooling comes courtesy of two rear fans and one side fan, and there are mounts for extra blowers in the front of the case and next to the hard drives. Antec also had the presence of mind to install a filter on the PLUS1080AMG's front air-intake and a wire loom on the ATX power cable, both of which are important but often overlooked features. The aforementioned power cable is attached to a beefy 430-watt Antec TruePower power supply. One FireWire and two USB ports provide front-panel I/O.

The edges of the case are folded, so there's no danger of slicing open your thumb while installing a new videocard. The drive-bay roll call includes four 5.25-inch bays, two external 3.5-inch bays, and four internal 3.5-inch bays in a pop-out cage. Screw-on drive rails are included, and unused rails can be strapped to the floor of the case so they don't get lost.

Unfortunately, the PLUS1080AMG uses standard screws instead of convenient thumbscrews, and the motherboard tray is nonremovable.



Cooler Master ATC-101

With its metallic design and optional Plexiglas case window, the Cooler Master ATC-101 is as sleek and slick as an international jewel thief. But this enclosure's not just pretty, it's also ready to perform under pressure.

The case comes bundled with a nice load-out of fans, which isn't surprising considering Cooler Master's vast experience with cooling apparatus. The ATX-compatible motherboard tray slides out effortlessly for convenient upgrading, and as the tray slides out, so does most of the back panel, so your cooling setup doesn't bang its head during egress. Thumbscrews are used for the side panels, PCI slots, and the removable motherboard tray. This makes it easy to swap add-in cards.

The Cooler Master's front-mounted USB ports should appeal to anyone who wants to avoid crawling underneath a desk. But don't worry about an unsightly port marring the case's picture-perfect facade, because both ports are hidden behind a tiny aluminum door.

The edges of the case aren't particularly sharp, but we'd still prefer folded edges. We've also grown quite fond of drive rails, so we were disappointed that the ATC-101 lacks them. But these are minor gripes in light of all the Cooler Master's perks.



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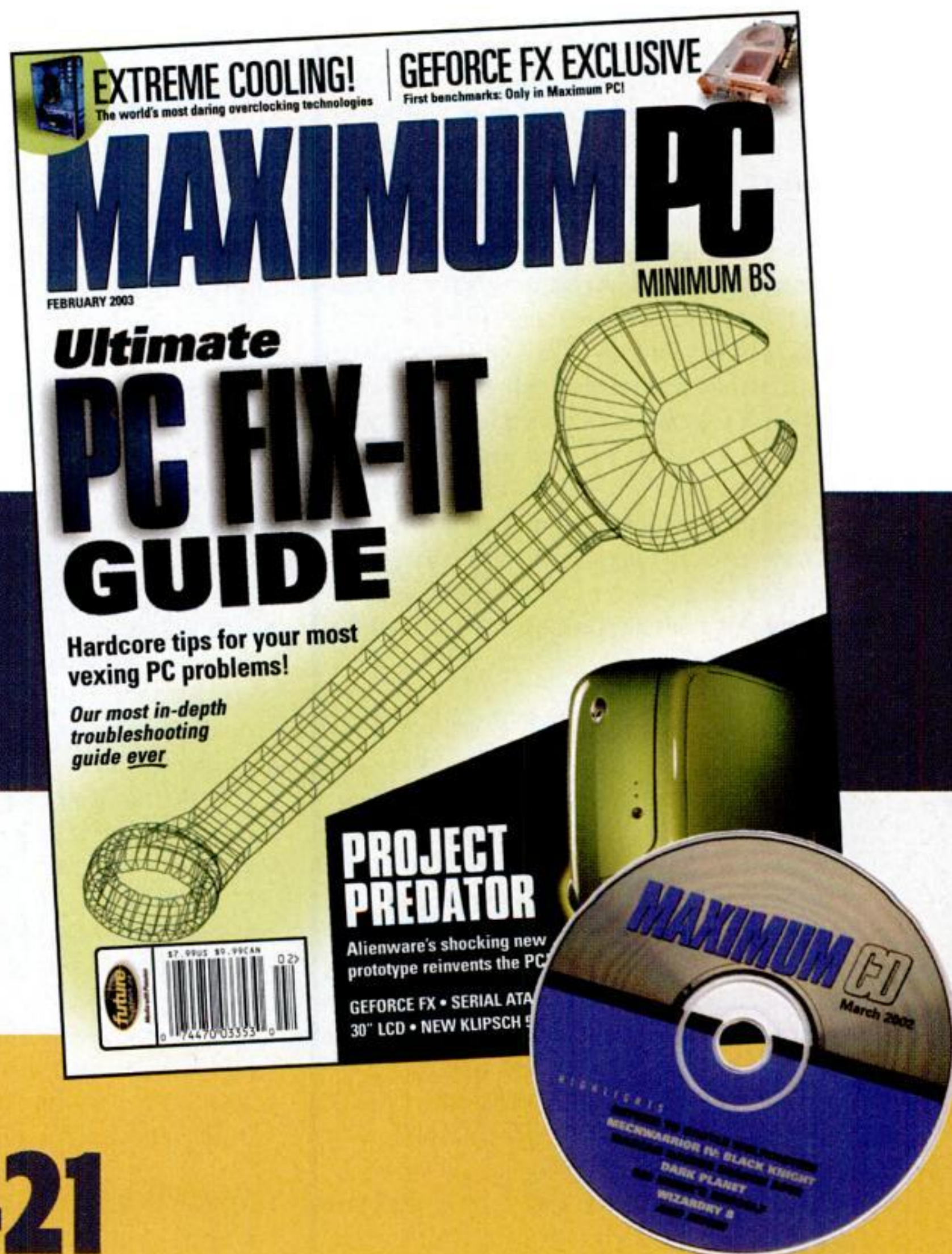
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How To Pick the **BEST** MINI-SYSTEM

Little boxes don't have to mean big compromises

Once upon a time, owning a powerful system meant sacrificing a fat chunk of desk real estate to a massive tower. If you wanted a computer that was slim, stylish, and portable, you pretty much had to buy a Mac (shudder). Thanks in large part to the efforts of a Taiwanese motherboard maker called Shuttle, those days are long gone. The company made a name for itself selling do-it-yourself kits that included a small, attractive case and a tiny motherboard with tons of built-in features.

Shuttle's innovative idea has since been mimicked by countless competitors, and it has become a daunting task to pick out the perfect mini-system kit. Choosing the right mini-system is a critical decision, too. The kits lean toward the expensive side, and since most of the components in a given kit are proprietary (meaning they were designed for that particular case, and not to be used with other manufacturers' products), you can't easily swap out the core parts. So we're going to tell you exactly what to look for in a mini-system, and dish out some of our recent mini-system reviews so you know which ones are hot and which ones are not.

ENGINEERING AND BASIC DESIGN

There are generally three types of people who buy mini-systems: People who lack desk space, people who move their computers around a lot, and people who just can't get over how darned cute the wee things are. Unless you fall exclusively into the third category, you'll want your mini-system to be small, light, and easily portable. Frequent LAN party attendees will also want to look for a model that has a built-in carrying handle. And of course, regardless of your reason for buying a mini-system, chances are you'll want to look for one that's sleek and stylish. Some of the latest mini-systems even come tricked out with case windows and neon LED-adorned

fans—if that's your fancy.

If you've ever tried to build a mini-system before, you know what a pain it can be to cram all your hardware into such a tiny space. All mini-system kits are not created equal in this regard, however. Some kits include features such as a removable top and removable drive cage that make component installation less of a chore. Trust us: If you're planning on ever upgrading or replacing the hardware inside your mini-system after the initial installation, you'll want these features. Unless you're a skilled contortionist, of course.

Finally, it is of utmost importance that a mini-system come with a quality power supply. Mini-systems often can't fit more than a 200-watt power supply within their cramped quarters. Thus, it's necessary that this power supply be high-quality and capable of consistently delivering its maximum wattage. Upgrading the power supply in a mini-system is not usually an option, so if you want to run the latest hardware, make sure your mini-system's PSU is up to the task.

Unfortunately, it's difficult to ascertain the quality of a power supply without actually operating the mini-system. So if you decide to deviate from our recommendations at the end of this article, be sure to check out the *Maximum PC* forums and listen in on the chatter about the system you are considering. In particular, look out for posts that complain of instability running the latest hardware under high-stress situations.

KEEPING YOUR COOL

A mini-system's dearth of internal space makes the management of heat an issue. A well-designed cooling setup should keep all the parts in your



Shuttle pioneered the mini-case as we know it today, and the company has no problem keeping up with current technologies, like a chipset that supports Hyper-Threading in this XPC SB51G.

rig from overheating by channeling heat away from components and directing it out of the case. However, it shouldn't sound like a wind tunnel. This is a tricky balancing act to pull off. In our experience, Shuttle comes closest to the sweet spot, thanks to the innovative heat pipe (a hollowed-out tube that transfers heat energy away from your CPU and out the case) that ships with its mini-systems. Many mini-systems will also include wire clips and guides and rounded cables to help improve internal airflow—a nice touch that not only looks good, but is utilitarian as well.

LITTLE CASES, BIG TECHNOLOGY

The wee, proprietary motherboard that comes in a mini-system is generally not upgradeable, so you'll want to make sure it's a good one. Intel fanboys and girls will want a chipset that supports Hyper-Threading technology, as well as an 800MHz (or at least 533MHz) frontside bus. Meanwhile, AMD loyalists should seek out a mini-system that uses nVidia's fast and reliable nForce2 chipset—preferably one that can run the new 400MHz FSB.

As for memory, it's typical for mini-

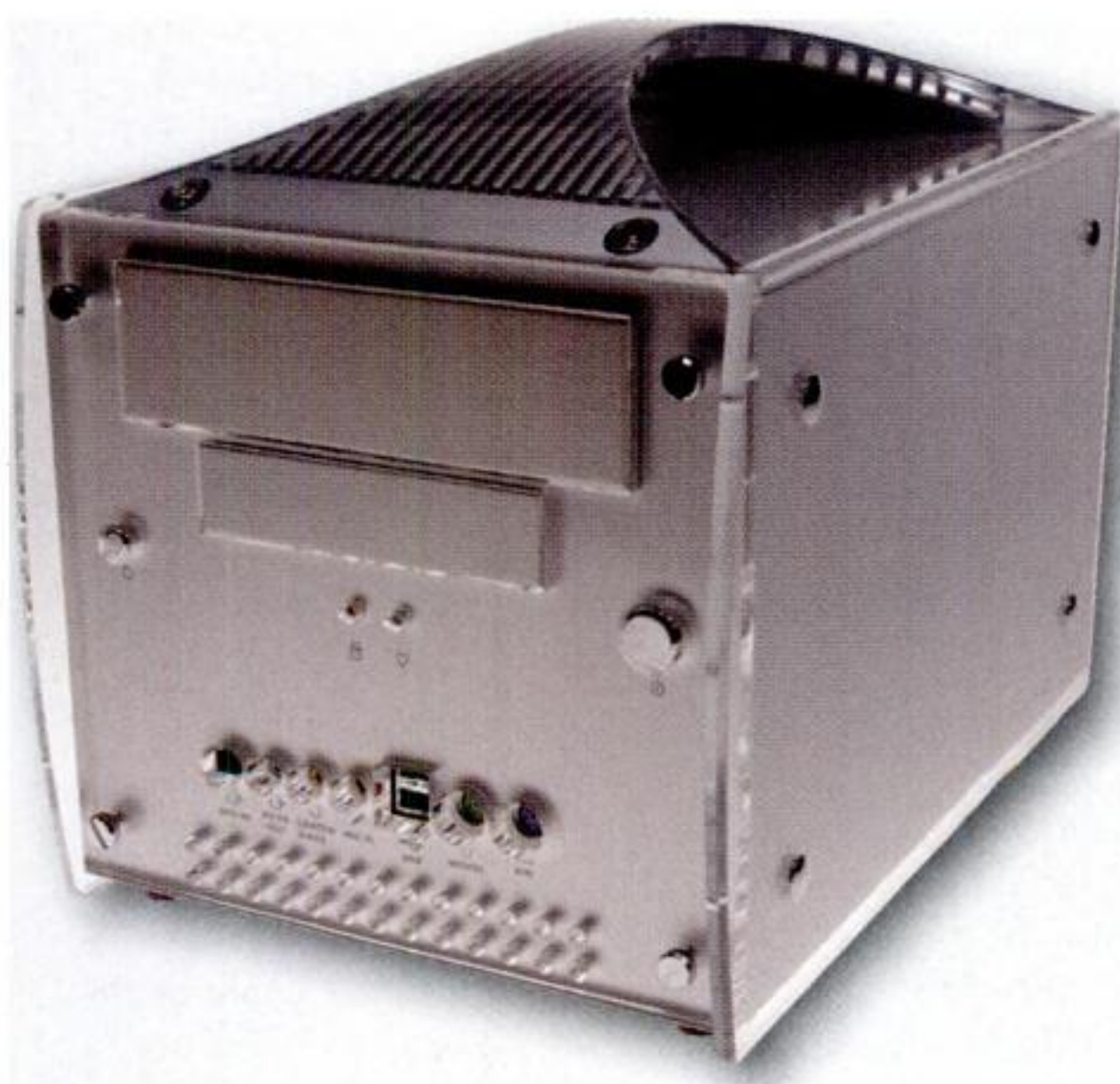
top picks

systems these days to have two DIMM slots. The nForce2 chipset offers dual-channel capability (which doubles memory bandwidth when at least two sticks of RAM are installed)—a boon for performance. We haven't yet tested any dual-channel Pentium 4 mini-systems, but the first wave of them was hitting the streets as of this writing. If the option is available, pounce on it, since dual-channel technology dramatically boosts P4 performance.

Expansion-wise, most mini-systems come with one AGP slot and one PCI slot—avoid any system that denies you either of these slots. Because a mini-system's expansion capabilities are severely limited, you'll want yours to come with as many integrated features as possible to minimize the need for add-in cards. Most companies' offerings include onboard LAN, audio, and video. Granted, integrated audio and video aren't top quality; if we could get by relying on just one, it would be integrated audio.

Finally, avoid squandering your PCI slot on an add-in USB 2.0 or FireWire card by buying a mini-system that sports built-in USB 2.0 and FireWire (remember that USB 2.0 is about 40 times faster than USB 1.1!). The majority of mini-systems have a plethora of convenient front-panel I/O ports, including USB, FireWire, and even audio. If you want easy access to a headphone jack, or if you often use USB keys or external drives, don't deprive yourself of front I/O.

With that said, let's move on to the reviews so you can get a good idea of what's out there in the mini-system market today.



Front-mounted I/O ports (that let you jack in headphones, USB and FireWire devices, and even line-in audio) are easily overlooked when shopping for a mini-case, but you'll kick yourself later if you don't have them.

SHUTTLE SN45G

The SN45G comes in a beautiful brushed-aluminum case that will fit right in with your living room hi-fi equipment. On the front, you'll find convenient audio and USB ports, plus a lone FireWire port. Unfortunately, the front-mounted FireWire port is four-pin. Two six-pin ports are found on the back, too far out of the way for our liking. We also would've been happier if the case came with a carrying handle.

On the inside, things are near-perfect. The SN45G boasts nVidia's nForce2 Ultra 400 chipset, and offers plenty of overclocking options in the BIOS. Shuttle's trademark CPU heat pipe is included, and Shuttle throws in a copper shim to protect your Athlon's delicate core during CPU cooler installation. Expansion options are handled by one AGP and one PCI slot—and you'll need the AGP slot, since the SN45G doesn't include integrated graphics. The power supply is a mere 200 watts, but was up to the task of running a Radeon 9800 Pro, 7200rpm hard drive, and high-speed optical drive. Overall, the Shuttle SN45G is a beautiful piece of work, bringing mini-system salvation to Athlon lovers.



SHUTTLE SPECS

Power supply	Enhance ENP-2320 (200W)
Mobo/chipset	Shuttle FN45G/nVidia nForce2 Ultra 400
Expansion	Two DDR DIMMs, one PCI, one AGP 8x

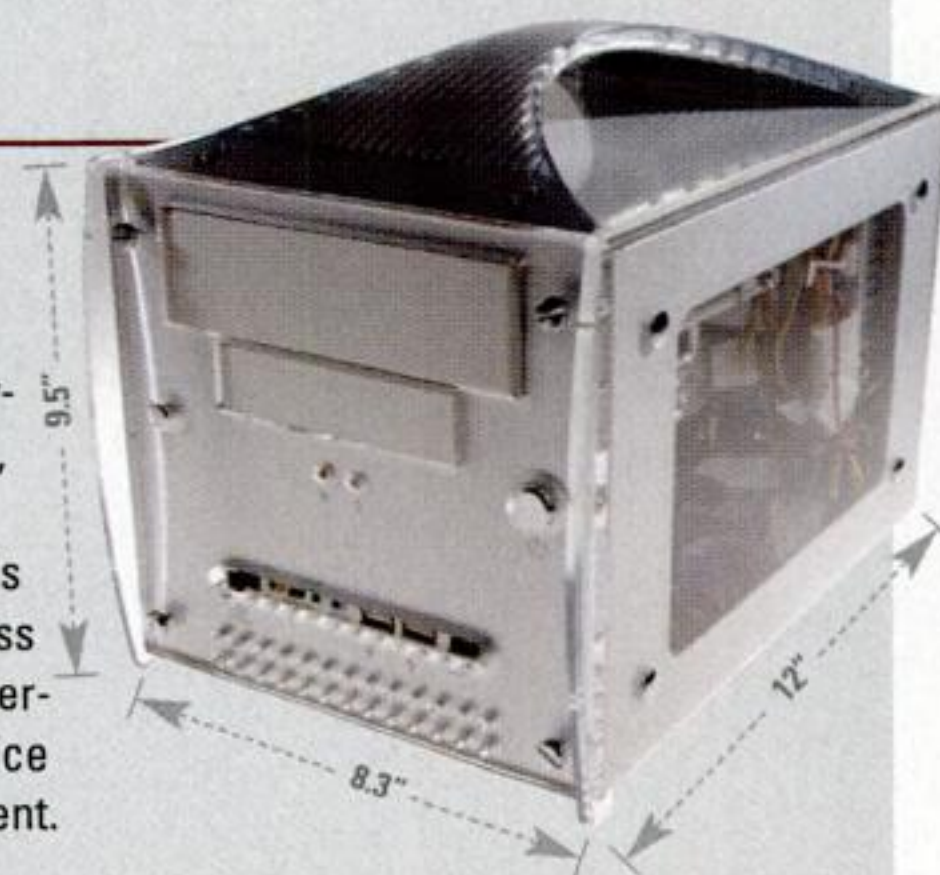
FIC ICE CUBE-VG61

With two see-through sides, a glowing translucent heatsink/fan combo, and a great curving handle that arches over the length of its top, this system is perfect for parading across promenades on a sunny Sunday afternoon. The small box also packs a nice punch in the performance department.

Working inside the case, you'll find that the removable 3.5-inch drive cage helps mitigate the space restrictions that are created by the enclosure's design (which lets you remove only the sides, not the top). The IDE cables have been shortened and folded, adding to the rig's coolness and overall space economy. Side-by-side AGP and PCI slots allow you to get busy with expansion matters, and three FireWire ports are ready for DV cam and external hard drive action.

Though this tiny titan lacks the side venting that's present in the other boxes, the airflow seemed to be well-planned, as we didn't notice any scary heat buildup. The lack of venting also significantly reduces the overall noise of the system by restricting the noise emission to the two rear-mounted fans.

With solid performance, easy internal access, airflow happiness, and a sturdy handle, the FIC is a fine choice for LAN partyers looking for a bit of flash and dash.



FIC SPECS

Power supply	CWT-220 FXC (220W)
Mobo/chipset	Chyang Fun CF-S96/Intel 845GE + ICH4
Expansion slots	Two DDR DIMMs, one AGP, one PCI

How To Pick the **BEST** CPU

We picked our brains to help you pick your PC's brains

One of the most important decisions you're going to make when building your new PC is which CPU to use. Choosing an Athlon XP or Pentium 4 will dictate what motherboard you buy, what kind of RAM you'll want, and how fast your applications can do what they do.

Before we look at what each of the two major CPU manufacturers has to offer, let's take a quick look at the first thing on everyone's mind when choosing a CPU—the mighty megahertz.

MEGAHERTZ: DOES IT REALLY MATTER?

Watching the meteoric rise of the Pentium 4's clock speeds, we've certainly been conditioned to think that megahertz is the final word on processor speed. But the truth is that given the differences between the architectures of the two leading CPU families (the Athlon XP and the Pentium 4), clock speed can be misleading. Although it's still an important metric of brute strength, factors such as application-specific optimizations can be just as crucial.

To give you an idea of how drastically different the design can be from CPU to CPU, consider the original Pentium 4. Launched at 1.5GHz, many people reasonably assumed the Pentium 4 was much faster than the Pentium III, which at the time was limited to 1.1GHz. Due to the core architecture differences, the Pentium 4 was actually *slower* in many applications that were out at the time, despite its 400MHz clock-speed advantage. One reason was that applications weren't yet optimized to take advantage of the P4's architecture. But the other culprit was the P4's

lengthy instruction "pipeline."

If you think of a CPU as a car factory, then there would be 12 people working on the assembly line at the Pentium III factory (in what's called a 12-stage pipeline). Each person performs a few tasks on the job at hand before it's moved to the next person. At the Pentium 4 factory, there are 20 people working on the assembly line (a 20-stage pipeline). Because each person does less at each stage, the assembly line can move much faster than at the Pentium III factory. However, sometimes things go wrong and the entire job has to be scrapped ("oops—we ordered the wrong part"). In a CPU, that's called a "branch misprediction," and it's quicker to get the assembly line back up to speed in a Pentium III because there are fewer stages.

Originally the P-III, as well as AMD's Athlon, gave the Pentium 4 fits by being as fast or even faster than the new flagship Intel chip. But that was nearly three-years ago. Buzzing along at more than twice the speed it was introduced at, the Pentium 4 is the recognized speed

leader today. The long pipeline of the P4, which Intel designed to hit high clock speeds, is now paying off.

That doesn't mean, however, that an Athlon XP running at 2.2GHz is always going to be slower than a Pentium 4 running at 2.5GHz. Because of the Athlon XP architecture, and the amount of older applications that rely heavily on such things as floating-point math, the Athlon XP is still quite a competent performer. Although clock speed still matters, you have to treat the CPUs as though they are on different scales. The megahertz in a P4 and an Athlon may not be equivalent in terms of the amount of work that gets done within each clock cycle.

Nonetheless, the P4's scale probably goes all the way to 5GHz or 10GHz, whereas the Athlon XP stops at 2.25GHz.

INTEL—THE PROCESSOR GIANT

Intel is the largest semiconductor manufacturer on the planet, and as such, they've had a hand in developing a majority of the technolo-



Do your proper research! Only a sucker would invest in the Pentium 4 "Willamette" in Socket 423 trim.

gies powering today's PCs, including PCI, AGP, PC100, AC97, USB, and PCI Express. The company's biggest hit has been the Pentium processor and its heirs. The Pentium 4 is the company's flagship CPU today. Although you can still buy Pentium IIIs, they've long been banished from desktop systems in stores. We'll still touch on them a bit, but we strongly advise against purchasing a P-III in favor of a P4 or AMD processor. There are far better ways to shave off costs than going cheapo on this crucial component. We, of course, recommend that you buy the newest, fastest P4 possible.

THE PENTIUM 4

There are several different versions of Intel's flagship on the market today: the P4A, the original "Northwood" Pentium 4 with 512KB of cache that ran on a 400MHz bus and used a 0.13-micron core; the P4B, which is the Northwood running on a 533MHz bus; and the new P4C, which uses an 800MHz bus.

The P4 architecture has a lot of headroom left—it's expected to reach 5GHz and beyond! The P4 is also unique in its support for Hyper-Threading.

A good portion of a CPU's resources aren't used all the time. If it's calculating something with the floating-point unit, the other portions are sitting idle. To address that, Intel added Hyper-Threading to the core. Hyper-Threading essentially splits a single physical CPU into two virtual CPUs. So while one application is running floating-point operations, another can use the remaining free resources of the CPU. It's a boon to people who run multiple applications simultaneously. Hyper-Threading is generally recognized to be a performance booster, especially for multitaskers. There are occasions when the CPU can run slower because two floating-point-heavy applications are trying to vie for the same physical resources, but we've mostly found it to be useful. Hyper-Threading is only available on the 3.06GHz P4 and the newer 800MHz bus Pentium 4 CPUs.

Next year, Intel will retrofit the chip with even more cache and move it to a 0.09-micron process.

CELERON

Today's Celeron is a Pentium 4 die with just 128KB of cache and is confined to a 400MHz bus. It even fits the same socket and operates in most motherboards built for the 400MHz and 533MHz Pentium 4s. It's more than enough for granny to browse the net, but we can't recommend it for power users.

XEON

If you want a dual processor box, your only option is Xeon. But you'll pay dearly for the privilege. Based on the Pentium 4, the Xeon adds a host of features designed for high-end servers—such as a whopping 2MB of cache—that make these procs enormously expensive.

AMD— THE FEISTY UPSTART

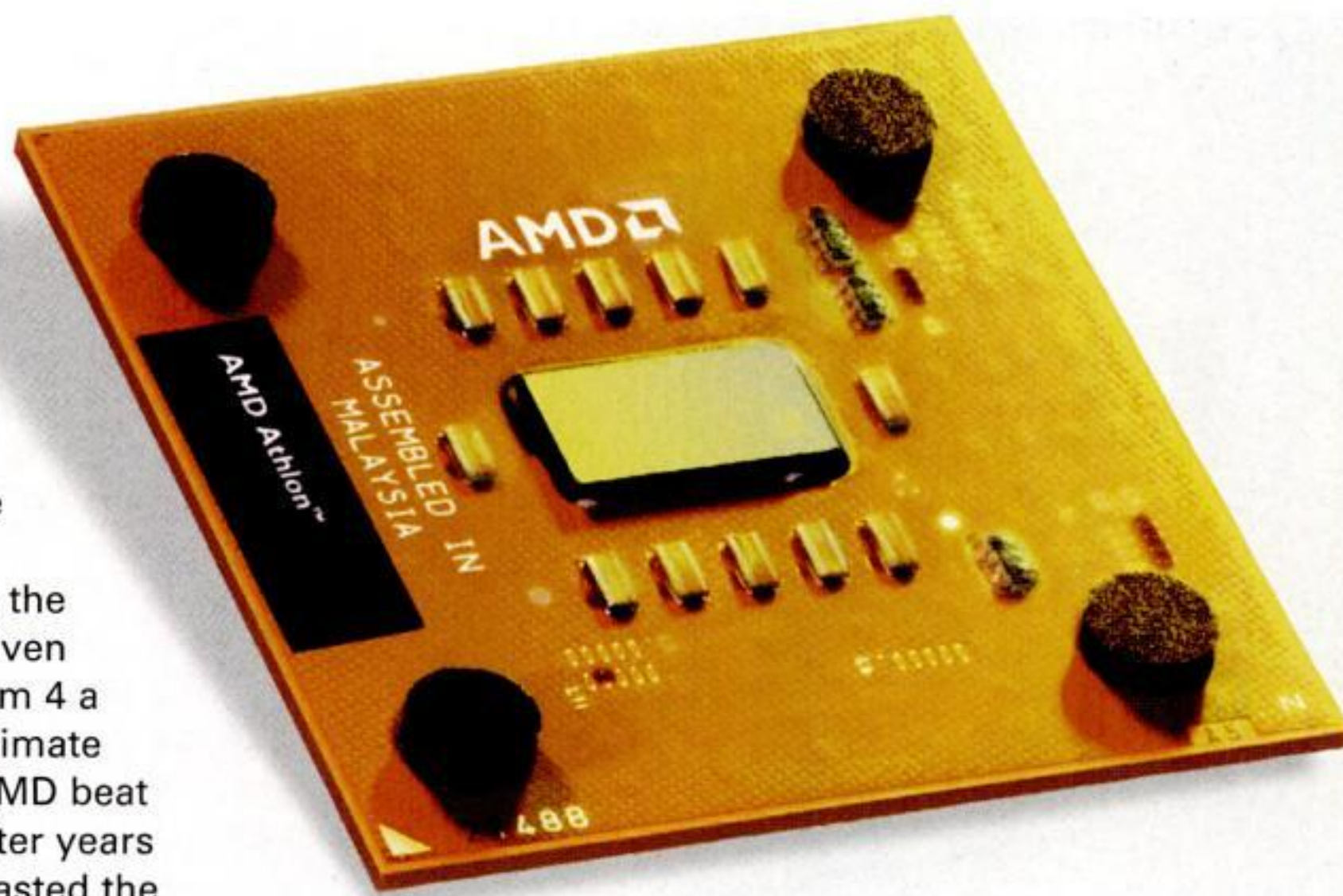
In the four years since the introduction of AMD's Athlon line of processors, the Athlon has consistently given the Pentium III and Pentium 4 a run for the money. The ultimate humiliation came when AMD beat Intel to the 1GHz mark. After years of eating dust, AMD has tasted the sweet nectar of victory and has no intention of giving up. The company's Athlon XP is its flagship consumer CPU, but by the time you read this, AMD should be in transition to the Athlon 64, which will be the first desktop CPU for the PC with 64-bit support.

ATHLON XP

The fastest Athlon XP available today clocks in at 2.2GHz, uses a 0.13-micron process, packs 512KB of L2 cache, and runs on a 400MHz bus. AMD designed the CPU with a pragmatic approach. Its older CPUs were criticized for having poor floating-point performance, so the Athlon XP was designed to be a screamer at floating-point math. (Intel took the opposite approach—the P4 is fairly weak in floating-point performance, but strong in special instructions, which Intel believes are more appropriate for the future of intense math on computer chips.) The Athlon XP's FPU performance makes it ideally suited for older mathematic and scien-

tific applications that have not been optimized for the Pentium 4.

With the Athlon XP, AMD also implemented a controversial performance rating. Instead of using the standard metric of megahertz, a 2.167GHz CPU with 256KB of L2 cache and running on a 333MHz bus is marketed as an Athlon XP 3000+. What does the 3000+ mean? AMD swears on a stack of *Maximum PCs* that it's not analogous to a 3GHz Intel CPU. Despite this claim, it's just a little too convenient that the performance num-

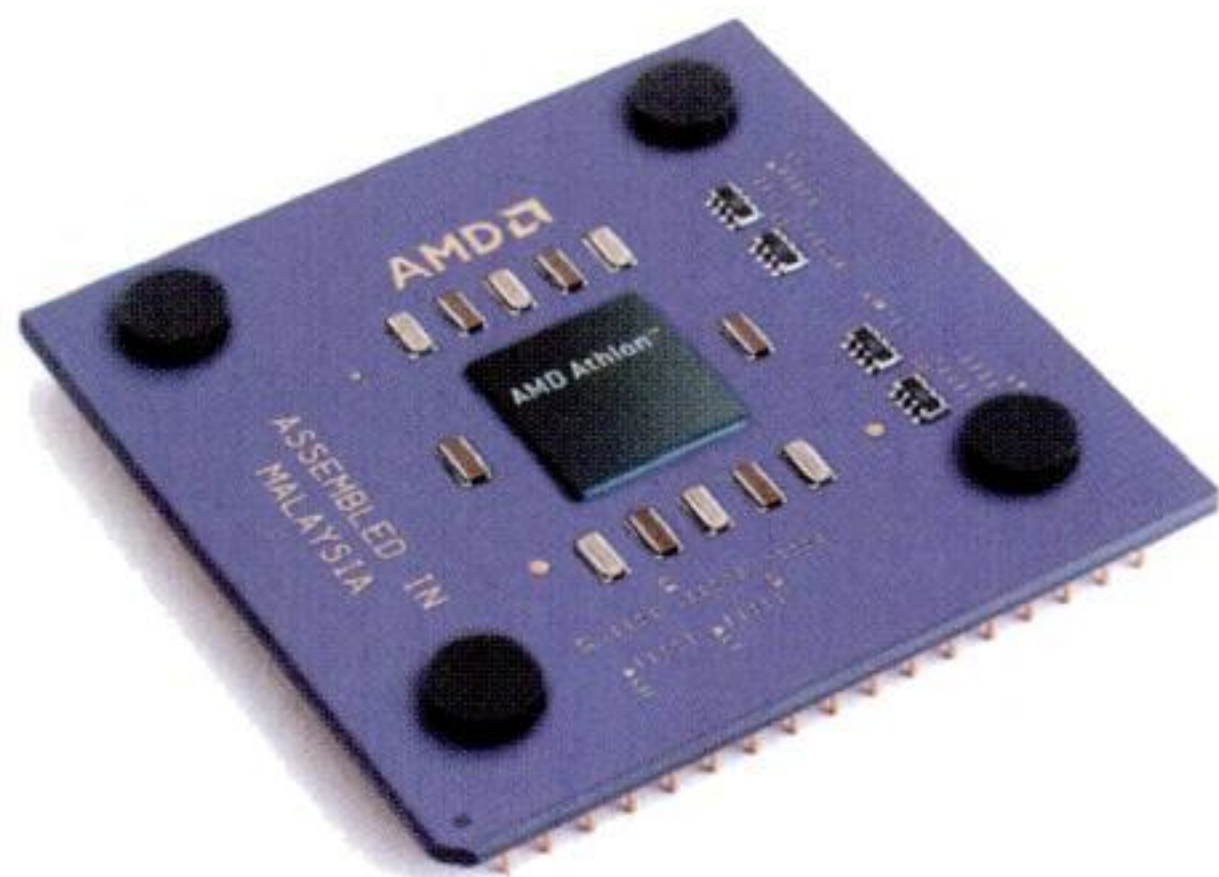


The "Barton" version of the Athlon XP features 512KB of L2 cache and supports up to a 400MHz frontside bus.

bers perfectly line up with Intel's frequencies.

For consumers, the numbering scheme actually makes sense, as the average Joe and Jane don't have the time or technical prowess to understand that a 2.2GHz CPU can run as fast as an Intel 2.8GHz CPU in some applications. For hobbyists though, it's a confusing mess. For example, AMD has two 3000+ CPUs. The original one clocked at 2.167GHz using a 333MHz bus, and a newer version clocked at 2.1GHz using a 400MHz bus.

AMD CPUs with the larger L2 cache of 512KB are generally preferred, especially when running on a 400MHz bus. You'll have to do a little research when buying the CPU, but most stores and web sites are very clear about labeling the attributes of the Athlon XP so



The original Athlon XP brought SSE to AMD's plate and introduced the controversial set of performance ratings.



AMD's new Athlon 64 series of CPUs brings 64-bit computing to the desktop. With 1MB of L2 cache and an integrated memory controller, the chip promises to be faster than the P4.



Intel keeps the Celeron in the CPU ghetto by limiting it to a 400MHz bus and cutting the cache down to a mere 128KB.

you don't get mixed up. AMD has plans for one more derivative of the Athlon XP with only 256KB of L2 cache, but that will likely be it for the Athlon XP lineup as the company begins pushing the Athlon 64.

ATHLON MP

Take an Athlon, test it for compatibility in a dual processor configuration, and you have an Athlon MP. The Athlon MP was supposed to be AMD's big push into small scale servers, but it's hindered by a lack of chipset support. The 760MPX chipset with support for just a 266MHz bus and DDR266 is still the sole chipset. Not being a candidate for higher bus speeds, higher RAM speeds, or such amenities as high-speed USB 2.0, the Athlon MP is pretty much an end-of-life product. The final chip, the Athlon MP 2800+ features 512KB of cache and runs at 2.13GHz.

DURON

This is AMD's version of the Celeron. A budget chip built off a derivative of the Athlon, the Duron has just 64KB of cache and is limited to a 200MHz system bus. In the early days, the Duron could outbox a low-end Celeron, but today it's outclassed by Intel's current generation of Celerons. AMD shelved the Duron earlier this year and will push the Athlon XP, or rumored Athlon "FX," into the low-end market to compete with the Celeron.

OPTERON

The Opteron adds 64-bit extensions to AMD's original processor recipe. The Opteron also breaks from convention by embedding a dual-channel memory controller directly into the die. Combined with the 1MB of L2, the Opteron looks like its well on the way to being a hit even at the low clock speeds of 1.8GHz. Opteron, however, isn't intended for desktop use—it's designed and priced for servers.

ATHLON 64

By the time you read this, AMD should have released the first 64-bit CPU for consumer use in a Windows-based PC. (Apple was the first to rush one out of the stables with their G5 series.) Based on the same "Hammer" core as the Opteron, the Athlon 64 has a few key features that differentiate it from its server/workstation big brother. While Opteron only supports ECC registered DDR memory at DDR333, Athlon 64 can run non-registered RAM at DDR400 speeds. The Athlon 64, however, is

handcuffed by its single-channel memory controller. For some odd reason, AMD chose to only support a 64-bit memory controller in the initial Athlon 64. Many believe the company will correct that early next year when it releases a CPU that supports 128-bit. Such a move will be painful for early adopters, though. Because the Athlon 64 uses an integrated memory controller, you can't swap out an early single-channel Athlon 64 for a dual-channel Athlon 64 without changing motherboards. The Athlon 64 will no doubt help move the PC forward, and it'll put a lot of heat on Intel, which has no 64-bit option for consumers at all.

SO WHOSE SIDE ARE YOU ON NOW?

"Intel or AMD?" It can be a tough choice. But it's not all about cache sizes, transistor counts, and which one has the better commercials. The perfect CPU for you will greatly depend on what you intend to do with it.

If you're interested in playing games, the Pentium 4 is the recognized leader for now. We haven't seen numbers from an Athlon 64 yet, but even AMD die-hards will admit that the P4 and its 800MHz bus have a leg up on the fastest Athlon XP available.

If gaming isn't your top priority, there are other factors that should contribute to your choice. If you use mostly older applications that have not been optimized for the P4, then you'll want Athlon XP. One such app is Adobe's *Premiere*. Even with a 1GHz lead, the P4 still can't beat the Athlon XP in this old but popular application. If there is an application that you use frequently and rely upon, you should fire up your browser and check out newsgroups or the software vendor's web page to see what CPU is recommended.

If you intend to handle a lot of media-intense chores such as MP3 encoding and DV editing with optimized apps, or 3D rendering with such programs as Newtek *Lightwave 3D*, go with the P4. We don't recommend investing cash on P-III, Duron, Celeron, or Athlon MP chips, as these are all dead-end chips. Xeon and Opteron are also too expensive in dual-CPU trim for consumers, and too much to tackle for a first-time build-it project. If you're unsure whether to build a P4 or Athlon XP box and you can suffer the wait, we recommend holding off a month or two to see how the Athlon 64 is received.

See page 32 for details about actually building an Athlon or P4 rig.

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Vu meter
Temp monitor
3 Stylish gauges



WAVE MASTER



Jet 7



AEROGATE II

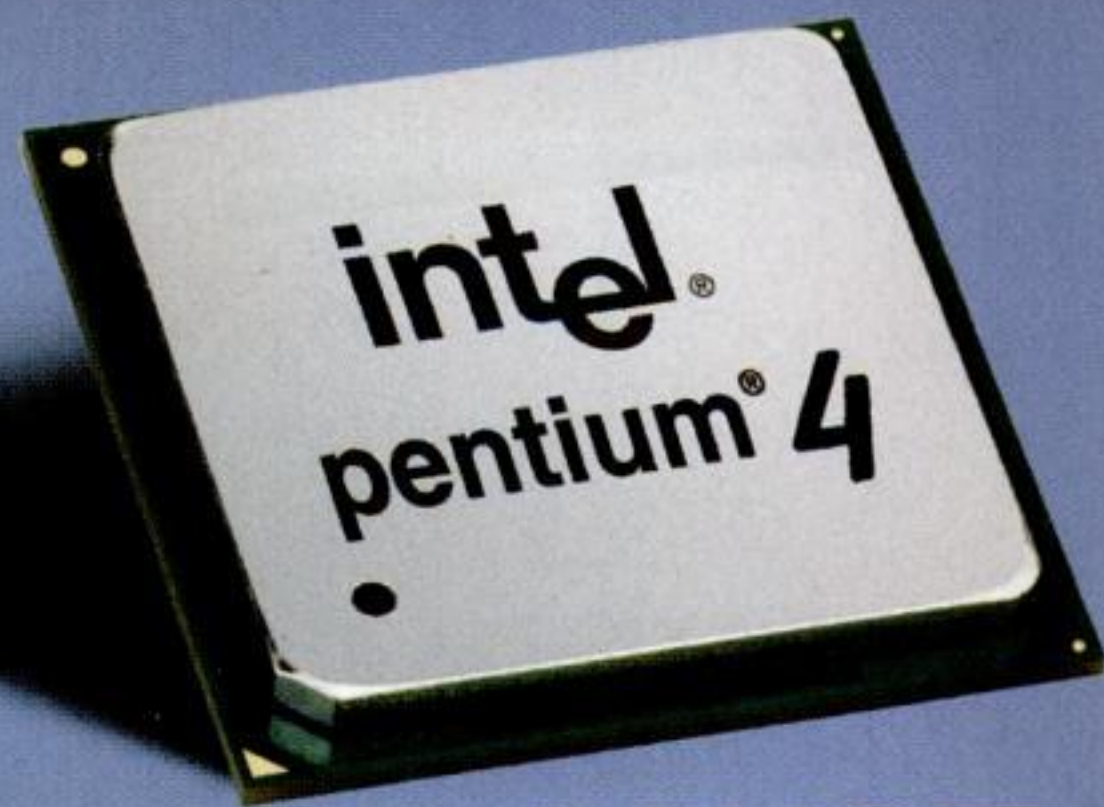


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The 10 Things You **MUST** Know about Building a P4 System

1 KNOW YOUR OPTIONS

There's a bewildering array of Pentium 4 CPUs on the market. The original 400MHz version, the second-gen 533MHz bus version, and the new 800MHz version. Intel only uses the designations A (400), B (533), and C (800) on chips that overlap in speed. So you can get a 2.4GHz A, B, or C version, but the 3.06GHz CPU doesn't come in a "B" since there's no 3GHz A version. Still we like to use the letters amongst ourselves for all P4s as a way of easily denoting a procs bus speed. Today, you want the C version for the best performance and Hyper-Threading capability.

2 THE SOCKET SWITCH

When browsing for a motherboard at Rutherford's Mobo Bazaar, don't grab the first box that screams "Pentium 4 compatible!" Although rare, there are still some old Socket 423 P4 boards among the Socket 478 boards. Today's technology demands the Socket 478, and you should settle for nothing less. That, of course, must be coupled with the proper chipset and bus support.

3 MEMORY MATTERS

Sometimes, choice is a pain. Chipsets for the P4 support PC133 SDRAM, PC800 and PC1066 RDRAM, and DDR266/333/400 in both single and dual modes. Whew. Unless you've got a closet full of RDRAM, PC133, or low-grade DDR, you should only buy a motherboard and chipset that supports DDR400 in dual-channel mode and 800MHz Pentium 4 chips. Intel's 875P, 865PE and 865G are the chipsets of choice, but VIA and SIS have compelling chipsets that also support DDR. Just remember that you need to pair the chip with the chipset and RAM. The 875P, for example, only runs at DDR400 with an 800MHz frontside bus CPU.

4 PERFECT PAIRS

Dual-channel DDR isn't new RAM, it's just two of the same single-channel modules run in tandem. The big question for builders is whether to pay more for a pair of modules that are "matched" from the factory, or to skimp and use an old module paired with a new one. If you choose the latter, make sure the new module is the same size as the old module and close in speed. The best performance will come from matched modules, but we've had some luck running mismatched modules. We recommend shelling out the cash for the least amount of trouble.

5 THE FUNNY PLUG

Because the Pentium 4 requires so much power, Intel ordained a new square-shaped plug that supplies extra juice to the CPU. So, when buying your case or power supply, make sure it reads "Pentium 4 compatible" or "ATX12V." Most P4-ready power supplies should handle any hardware config you throw at 'em, but just to play it safe, you should buy at least a 350-watt supply from a reputable vendor such as PC Power and Cooling, Enermax, or Antec.

6 CASE STUDY

When Intel introduced the P4 in January 2001, the CPU's heatsink required a computer case with four strategically placed screw holes—the heatsink was so heavy, it had to be bolted directly to the case! So, if you're going with a Socket 423 Pentium 4 CPU, make sure your case is compatible. Later Socket 478 Pentium 4 heatsinks use a plastic clip that firmly bolts to the motherboard, thus doing away with the need for a special case.

7 DRIVE SAFELY

Make sure you load your motherboard's chipset drivers immediately after loading your OS (you can get them from your motherboard vendor's web site—check back often for new and improved updates). If you don't load these drivers, the chipset and OS will never really work correctly and you'll suffer a big performance hit.

8 PREPARE FOR PRESCOTT

Sometime this fall, winter, or early next year, Intel will introduce a new chip code-named Prescott that will use a 0.09-micron process. This chip will have 1MB of L2 cache as well as other new features. It'll also be a big fat power hog, and it's quite possible that today's motherboards, even the 875P, won't support the voltage requirements of the new chip at speeds above 3.4GHz. If you really want to future-proof yourself (good luck because Intel is planning a new CPU interface for late next year) you'll want a motherboard that will not only support Prescott, but also higher clock speeds.

9 MAKE MINE HYPER-THREADED

Intel's Hyper-Threading splits the resources of a single CPU in two so the chip can process two things at once. To the end user, it's like the computer has two CPUs. Although there are times when Hyper-Threading can hinder performance, for the most part, it's pretty useful stuff. If you're into encoding MP3s while running *Photoshop*, HT can provide up to a 30 percent performance boost. HT is only available on the 3.06GHz Pentium 4B and all C versions.

10 SMACK TALK

Even a die-hard with "Athlon Rulz!" tattooed on this chest has to admit that today's 3.2GHz Pentium 4 smokes the Athlon XP in most applications and games. Sure, odd applications like *Premiere* are still faster on the Athlon XP, but the P4 is the recognized speed king. If you really want to steam them up, point out that at least Intel doesn't resort to bogus PR ratings of 3000+ and 3200+ to sell its chips. Nyah!

The 10 Things You **MUST** Know about Building an Athlon XP System

1 MAY THE NFORCE BE WITH YOU

Oh, how the worm turns. Just two years ago, VIA chipsets helped push the Athlon to the forefront of performance. That ain't the case today. If you want the highest performing Athlon system today, you buy a motherboard with nVidia's nForce2 Ultra chipset in it. The nForce supports dual-channel DDR400, gives you real-time Dolby Digital encoding and does away with, well, those VIA southbridge issues that have plagued its chipsets. While nForce2 boards once cost \$200 or \$150, we've seen \$90 boards with the chipset.

2 HEAVY HEATSINKS

By far the hairiest aspect of building an Athlon XP system is the installation of the CPU heatsink. If you're not careful, you run the risk of hearing the dreaded "crack" of your processor's core. Safety starts with choosing the correct heatsink. There are literally hundreds of them available for the Socket A format, but you need to pick the safest one for your purposes. Check out the approved heatsink list at the AMD web site. Go to www.amd.com and type "Athlon XP thermal solutions heatsinks" into the main search engine.

3 SWEATY PALMS

Once you've got an approved heatsink, follow these precautions for installation: First, remove all the tape and plastic that might cover any thermal grease or thermal tape that the heatsink manufacturer provided. Second, never angle the heatsink more than a few degrees off of level with the motherboard. Doing so may put pressure on the corners of the processor core and could cause them to collapse and crumble. The correct way to install the heatsink is to lay it flat on the processor, without applying any pressure to the heatsink itself. While gently holding the heatsink in place, move the clip over the bottom side of the socket and onto the center lug. Now take the other side of the clip, and use either a screwdriver or socket adapter to gently move it to the center lug on top of the socket. Finally, immediately plug in the fan to avoid any chance of CPU burnout.

4 PROPER POWER

Because Athlon XPs run more efficiently and use slightly less power than previous Athlons, they're more forgiving when it comes to minimum power supply specs. Go back to the AMD web site and type in "Athlon XP recommended power supplies" for a list of approved supplies (the slowest XPs require at least a 250-watt supply, while the high-end CPUs need 300-watters). All Athlon XP power supplies should have a +5VDC rail from the supply to the motherboard.

5 MEMORY MATTERS

There are a lot of people who believe that dual-channel DDR400 for the Athlon XP is plain overkill. While that may be true in some benchmarks, we've seen plenty of tests that prove dual-channel is the way to go. If you never intend to upgrade beyond a CPU that supports a 333MHz frontside bus, don't waste the money on low-latency DDR400. Just pick up a couple sticks of DDR333 and get over it.

6 FRESHLY CLEANED WINDOWS

Among other improvements, the new Athlon XPs include the 3D Now! Professional instruction set, which natively supports Intel's SSE instructions. But please note: To leverage the new instructions, you'll need native support in the applications you run, as well as support in your operating system. Microsoft was able to leverage SSE to yield a few noticeable performance improvements in Windows XP, so a clean installation of the OS will give you the best Athlon XP performance.

7 DRIVERS WANTED

After installing your OS, you absolutely must install your motherboard chipset drivers in order to ensure reliability and optimum performance for all your parts. The driver CD that came with your motherboard should have everything you need, but if you're looking for the latest drivers, check online at either the chipset manufacturer's web site or at www.amd.com.

8 BESTEST BIOS

Chances are, your motherboard was sitting in a warehouse for a couple months before you ever got a chance to take it home. This means it might be saddled with an old BIOS version, robbing you of the performance enhancements that have been released since the boards' initial introduction. Downloading the latest BIOS and flashing it to the motherboard is the best way to make sure your motherboard is operating at top form.

9 PESKY PROBLEMS

System lockups aren't infrequent in freshly built Athlon systems. To prevent them, make sure you are (1) running the latest drivers for your all your parts—especially your motherboard and videocard, (2) using an officially supported frontside bus speed, and (3) using adequate processor and case cooling.

10 SMACK TALK

As the owner of a new Athlon XP system, you'll find yourself battling the hearsay of the Intel faithful. Just remind them that your system probably saved you a couple hundred bucks and that even though Intel's CPU has a one-third higher clock speed, it's just five or 10 percent faster.



MOBO

Audio CODEC: Most new motherboards feature integrated audio that's quite advanced from stereo output. The Analog Devices chip here supports multichannel output and advanced 3D audio.

I/O controller: The keyboard controller, PS/2 ports, serial port, parallel port, and floppy drive are controlled by this chip.

PCI slots: The peripheral component interconnect, or PCI, slot pushed aside the creaky old VESA local bus and ISA slots for peripheral cards. But with a 32-bit bus, a 33MHz pipeline, and a 5V power requirement per slot, it's now looking pretty old itself. Although PCI Express will replace it in 2004, we'll see motherboards with both PCI and PCI Express for the next few years. Don't settle for less than five slots on an ATX motherboard.

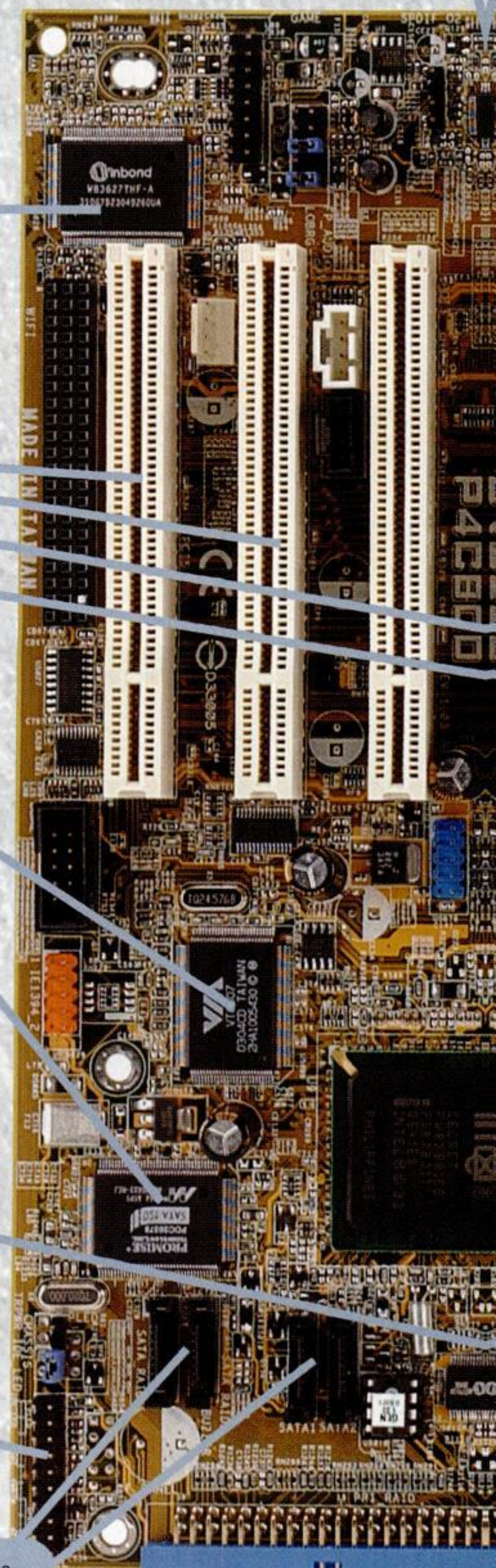
RAID and FireWire: Motherboard manufacturers build features into a motherboard by simply adding additional chips to the PCB, such as the Serial ATA RAID and FireWire A support on this board.

BIOS: The basic input/output system of your motherboard is contained in a small nonvolatile piece of memory. When you update the BIOS, this is the chip that gets reprogrammed. Generally, socketed designs are preferred. If you kill the BIOS during an update, or corrupt it with static electricity, you simply pry out the old one and replace it.

Front panel connectors: Plug your case's power-on switch, reset switch, hard drive light, and power lights into these pins.

Serial ATA: Serial ATA is on a rapid pace to replace parallel ATA. These slim ports support only one device per port. The two shown here are controlled by the south bridge, and another two are controlled by the Promise RAID controller chip.

Fan header: These three pins let you hook up auxiliary fans to your motherboard that can be intelligently controlled by the board (if it supports software control).



NIC: Most modern motherboards have built-in networking. The chip here is a 3Com Gigabit Ethernet chip.

AGP slot: Intel introduced the accelerated graphics port as a kind of express lane to the north bridge, so that graphics data wouldn't get tied up in traffic with data from other PCI cards. The most modern form of AGP is 8x, which can theoretically transfer 2.1GB/s of data. This motherboard sports an AGP Pro slot which adds additional ground and power lines for higher-wattage graphics cards.

Clock generator: The clock generator on a motherboard does what it sounds like; it controls the clock on the PC that determines the clock speed. Don't confuse this with the real-time clock which controls the time and date stashed in a battery-backed chip called the CMOS.

CPU socket: This is where the brain of your PC wields its awesome power. This motherboard supports most iterations of the Socket 478 Pentium 4 and Socket 478 Celerons.

Power connectors: The 20-pin ATX connector powers a majority of the circuitry on motherboards and provides 5, 3.3, and 12V power, as well as ground lines. On Pentium 4 and Athlon XP motherboards, you're also likely to find a square power connector that provides additional 12V power and ground lines.

RAM: The state of the art in motherboard technology is now DDR400 in dual-channels. Don't be confused—dual-channel DDR doesn't require new RAM. If you currently have DDR RAM, you simply get another piece of RAM that matches it in size and speed. By running the RAM in pairs, you greatly increase the memory bandwidth. The notches in the center prevent you from incorrectly inserting the RAM, and the colors indicate corresponding channels that RAM should be paired up in.

ATA/IDE ports: Most motherboards support two IDE/ATA ports for up to four devices. ATA100 is the industry standard. Sadly, we've observed no real performance improvement from drives supporting the latest ATA133 spec.

Floppy port: Hook your ancient floppy drive to this port if you must. Enough said.

How To Pick the **BEST** P4 MOBO

A quality processor deserves a quality home

Intel's Pentium 4 line of processors has scaled to enormously high frequencies, going from a mere 1.3GHz to an unprecedented 3.2GHz in less than three years. Today, Intel dominates the high-performance computing sector almost indisputably. We think that AMD's Athlon XP is a better value, but if you care only about getting the absolute fastest performance possible, then you need a P4.

But you can't just drop a P4 CPU into any old motherboard and expect to get bruising performance—mobos are definitely not created equal. Your motherboard choice will have a major impact on your system's stability,

different kinds of memory, bus speeds, and CPUs. Here's a guide to everything you need to know when selecting a P4 motherboard, with reviews of our top picks at the end for those who know a good shortcut when they see one.

THE PRESCOTT "ISSUE"

First, there have been recent rumors that none of the current P4 motherboards will support Prescott, Intel's next-generation CPU core. This is, quite simply, a bunch of hooey. While it is true that not *all* current P4 boards will be able to run Prescott processors, some will. The root cause of the problem is the voltage regulator module (VRM), which regulates the voltage fed

to the CPU. The

Pentium 4 processor will work with a VRM that's compliant with version 1.0 of the voltage regulation spec, but Prescott demands a version 1.5 VRM.

Thus, any current P4 motherboard that uses a version 1.5 VRM should be compatible with Prescott, in theory. Personally, though, we wouldn't

count on Prescott support from any motherboard that doesn't specifically claim to offer it. To get the final word on Prescott support, check the web site for any mobo you're considering.

CHOOSING A CHIPSET

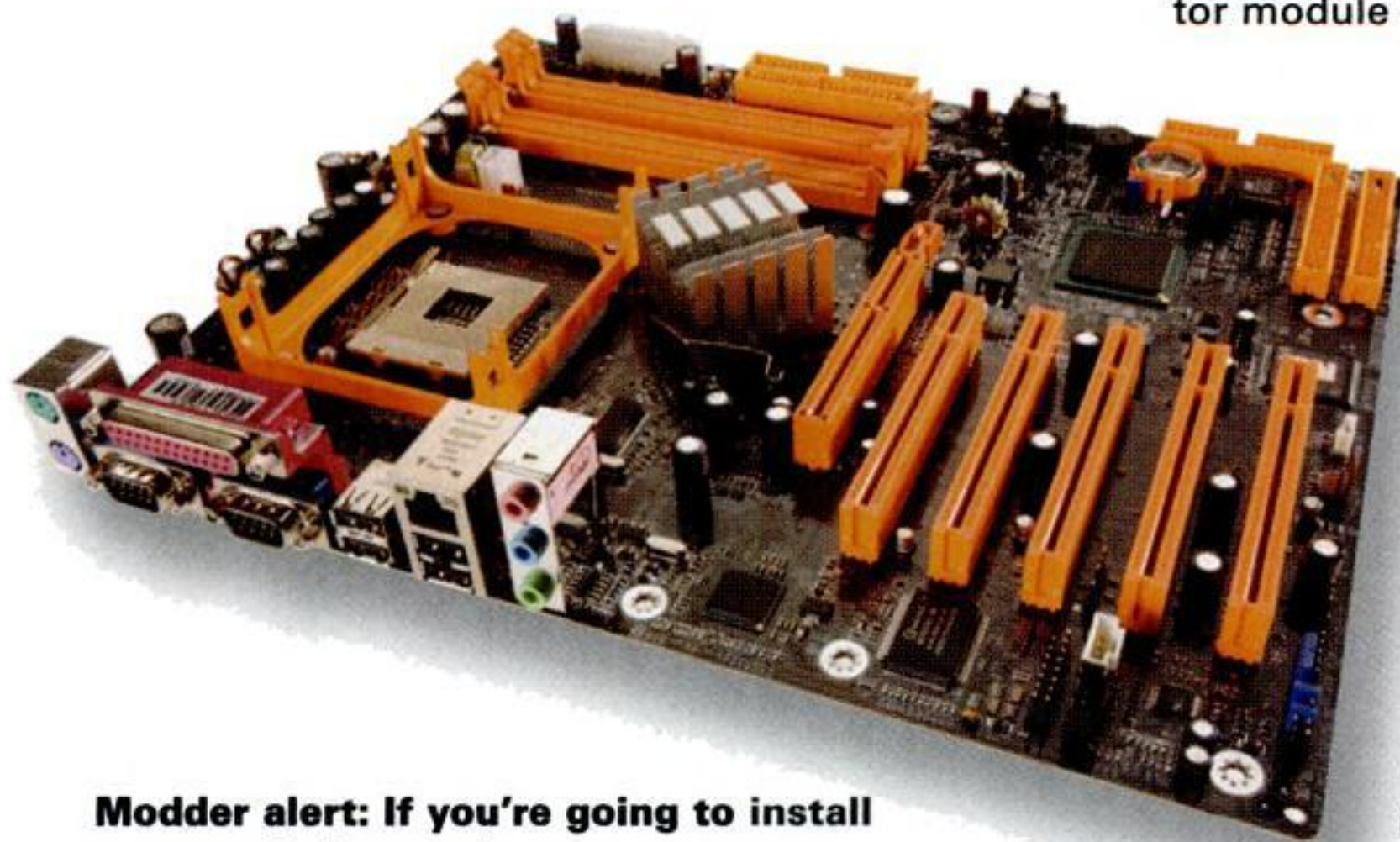
Before you can begin your search for the perfect motherboard, you need to know what chipset you

want—and there are a lot to choose from. As you might expect, the two best P4 chipsets out there right now are made by Intel. The 875P is Intel's top-of-the-line offering, sporting a dual-channel DDR400 memory controller, 800MHz frontside bus support, AGP 8x, and Hyper-Threading. Meanwhile, the 865PE is targeted more toward the budget market; it supports the same technologies as its older sibling, but can't sustain the same level of performance. However, many motherboard manufacturers have successfully hacked the 865PE to bring its performance to near-875P levels. We recommend both the 865PE and the 875P as our top picks for P4 chipsets.

ATI's Radeon 9100 IGP is another excellent chipset. It supports all the latest technologies—dual-channel DDR400, 800MHz FSB, AGP 8x, Hyper-Threading—and also boasts an integrated graphics core. Hardcore gamers and true performance enthusiasts will want to buy an add-in graphics card, but if your budget is tight, the 9100 IGP offers the best integrated graphics core of any chipset on the market. It's also the *only* chipset with integrated graphics to offer programmable shader support (which you'll need if you want to see next generation games like *Doom3* and *Half-Life 2* in all their glory).

Now that you've seen the contenders, let's look at the pretenders—the P4 chipsets you want to avoid at all costs. Intel's 865G and 865P chipsets are the bastard children of the 865 family. The former offers a GeForce2 MX-level integrated graphics core, but lacks the raw performance of the 865PE, while the latter is restricted to FSB speeds of just 533MHz. Meanwhile, from outside the Intel camp come the VIA PT600 and SiS 655FX. Both are dual-channel DDR400 offerings with 800MHz FSB support, but neither can match the speed or robustness of Intel's finest.

The future of chipsets on the Intel platform looks brighter than ever. VIA has two chipsets on the horizon that look quite compelling. The PT880 will boast a dual-channel DDR400 memory controller as well as support for



Modder alert: If you're going to install a case window, make sure you get a foxy looking motherboard, like DFI's fluorescent LAN Party Pro875.

upgrading potential, and overclockability. A good motherboard can also save you money by integrating features such as a RAID controller or sound chip, so you won't have to buy them separately.

There's a dizzying array of motherboard choices out there for the Pentium 4 right now, each offering support for



Some motherboard manufacturers offer an insane number of extras, including front bay-mounted media readers and even remote controls!

quad-band memory (QBM)—a special type of memory that offers twice the bandwidth of normal DDR. Motherboards based on the PT880 should be available by the time you read this.

Meanwhile, the PT890 will bring DDR-II and PCI-X support to the table, and is on track for release in the first half of 2004. Finally, Intel itself has an extra-fancy chipset in the works, code-named Grantsdale. This chipset will support PCI-X and DDR-II, as well as the new LGA 775 socket that will be used by later versions of Prescott as well as the still-distant Tejas processor. There will also be a version of Grantsdale with a third-generation integrated graphics core, for those on a budget.

BASIC FEATURES TO LOOK FOR

Chipset aside, there are certain basic features you should look for in any P4 motherboard. For one, you'll want support for dual-channel DDR400 memory. When sticks of memory are installed in pairs in a dual-channel-capable motherboard, the effective memory bandwidth of the system is doubled. This nifty trick works with standard DDR memory—no expensive special memory is required. The Pentium 4 processor thirsts for the bandwidth afforded by dual-channel DDR; when sandbagged by single-channel memory, the P4 loses much of its performance edge.

You'll also want to make sure the motherboard you choose can support the CPUs of today and tomorrow. Don't even consider a mobo that can't get on the 800MHz bus or run a 3.2GHz Pentium 4,

Abit motherboards are synonymous with overclocking, and the IC7-G Intel board lives up to expectations with a galore of features for practitioners of the dirty deeds

which is likely to be the final Northwood core CPU released.

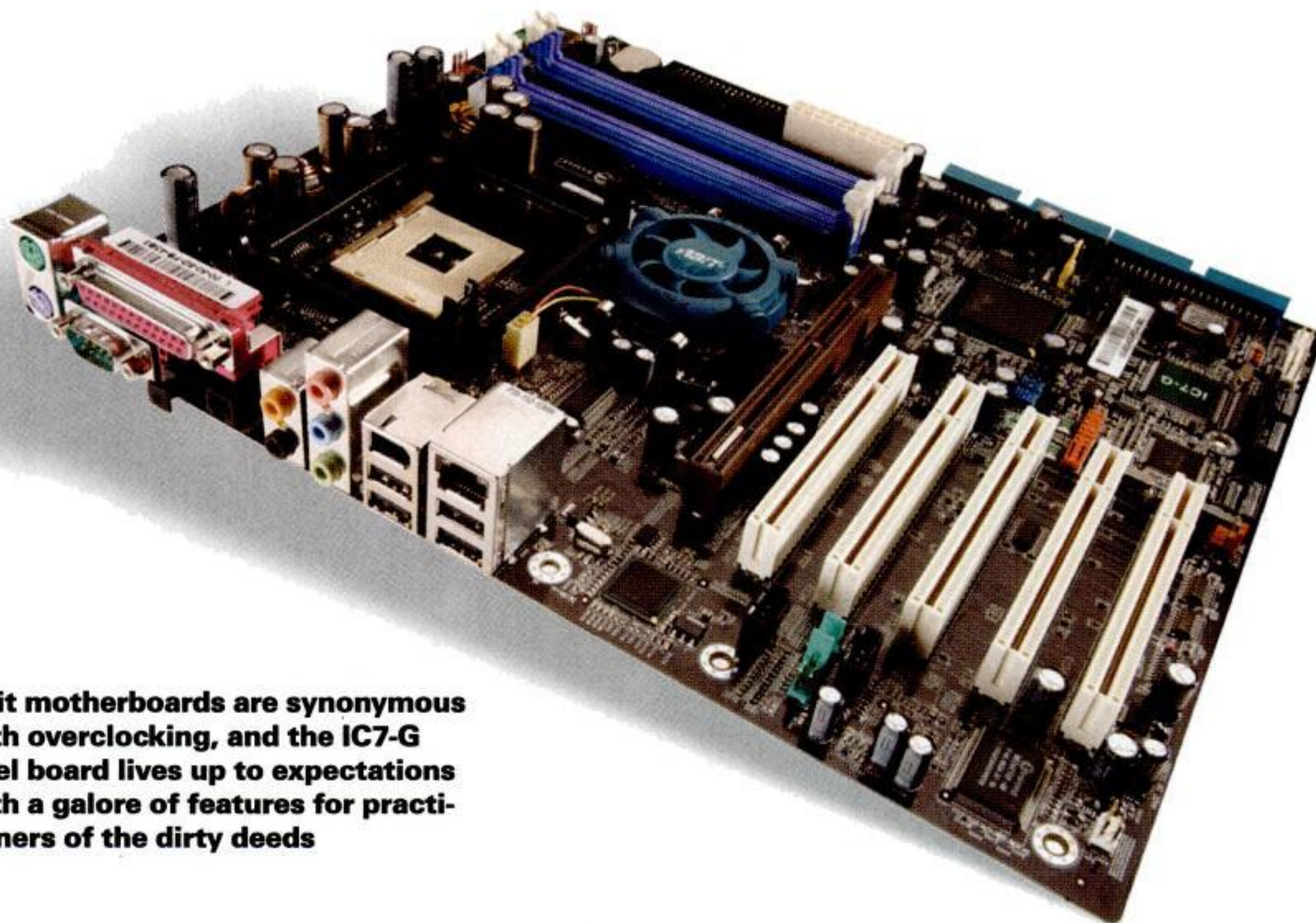
Other than that, look for a mobo that supports AGP 8x and features a retention clip to keep your videocard snug in its slot. Also, most motherboards released in the past few years feature a clean, jumperless design whereby key settings such as FSB speed are accessed through the BIOS. We still see evil mobos that use jumpers or DIP switches, so make sure you get one that's jumperless.

Finally, insist on a board that offers USB 2.0 and FireWire I/O, so you'll have high-bandwidth connections to your MP3 player,

digital camera, external hard drive, and any other peripherals you may have that support these high-bandwidth connections.

OVERCLOCKING FEATURES

Pentium 4 owners don't have as many overclocking options as Athlon owners, simply because the multipliers on a P4 can't be unlocked. Still, a good motherboard will allow you to make the best of the options you do have. If you're planning to do any overclocking at all, you'll want a mobo that allows FSB speed adjustments through the BIOS, at the very least. Otherwise you'll be stuck with the chore of fiddling



with hardware jumpers on the board itself. An ideal overclocker's board will allow the speeds of the FSB and memory to be set independently of the AGP and PCI bus clocks. In the past, overclocking the frontside and/or memory buses caused the AGP and PCI buses to run out of spec as well, which often limited the extent to which a system could be overclocked. Lately, however, some enthusiast boards have begun offering the ability to set these bus speeds independently.

EXTRA FEATURES

These days, integration is the name of the motherboard game. In a mad dash to one-up each other, motherboard and chipset manufacturers have started offering all sorts of extra features that can save you both money and expansion slots. Any motherboard you buy should offer integrated 10/100Mbps Ethernet at the very least. Depending on your needs, you may want to get a mobo with dual-Ethernet capability or Gigabit Ethernet. Should you decide to get a board with Gigabit Ethernet, look for one with a network controller that takes advantage of Intel's communications streaming architecture (CSA), such as the Intel Pro/1000. CSA allows the network controller to plug directly into the northbridge, so it doesn't suck bandwidth from the PCI bus—especially critical for the 1000Mbps transfer rates of Gigabit Ethernet.

Many boards these days also include a built-in RAID controller, allowing you to stripe your hard drives (for better performance) or mirror them (for data backup). The latest RAID controllers, however, offer what's known as RAID 1.5, a new spec that allows you to simultaneously perform striping *and* mirroring using just two hard drives. RAID definitely isn't for everyone, but if you're interested in taking advantage of it, look for a board that supports RAID 1.5, so you can get the best of both worlds. Meanwhile, if you want to plug in a next-generation 10,000rpm hard drive, make sure the motherboard you choose has a built-in Serial ATA controller.

Almost every motherboard now includes integrated audio, but it's hard to find one with *quality* integrated audio. In fact, for the Pentium 4, it's almost impossible—if you care at all about sound quality, we recommend you get an add-in sound-card, like Creative Labs' Audigy 2. You should also keep an eye out for any cool peripherals that may come bundled with a motherboard. Many boards now come with bonus-round toys like a remote control or even a carrying case for your PC. Others come dressed in sexy color schemes complete with fluorescent expansion slots, catering specifically to the case-modding crowd. And lastly, don't brush off the software bundle—while most mobos ship with a bunch of trashy programs, some come with useful apps such as a temperature monitor or virus scanner.

It's not easy to remember all the criteria for a good motherboard. But you've got another option—check out our top picks for Pentium 4 motherboards, tested and approved in the Maximum PC Lab.

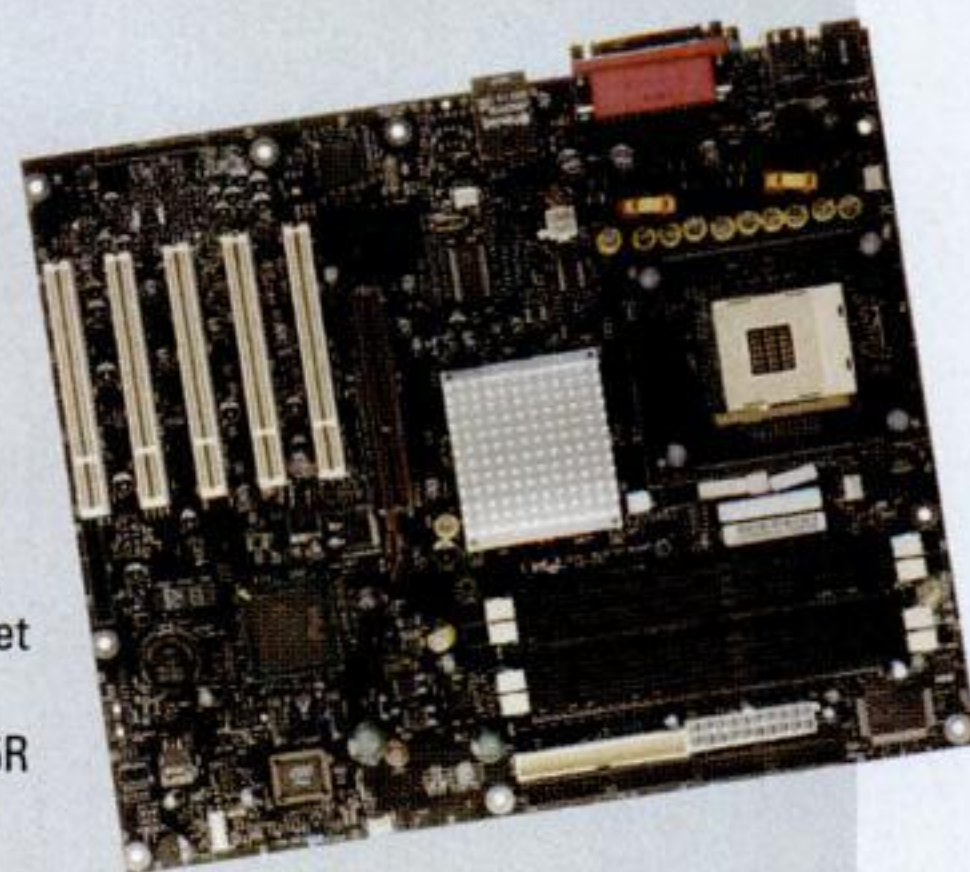
top picks

Intel D87PBZ

Built on the new 875P chipset, this board—code-named "Bonanza"—introduces Intel's move to dual-channel DDR400 RAM, and also showcases a host of new goodies, including an 800MHz system bus, 8x AGP, native Serial ATA support, and a special port that hooks gigabit Ethernet directly to the northbridge. The Bonanza board also features the ICH5R southbridge, which adds soft RAID Serial ATA to the equation as well.

To test its mettle, we pitted the 875P against the RDRAM-loving 850E; the DDR266 E7205; and SiS's hot new, DDR-crazy 655. We tested all four boards using common components and drivers (save respective RAM types). When all the smoke had cleared, we were left with super performance from the Bonanza and the 875P. The Bonanza was the fastest of the four in all our tests.

The Bonanza is also a departure from Intel's historically straight-laced board design. Outfitted to appeal to the moderate tweeker, Intel has included a "burn-in" mode that's really just an overclocking switch. Sure, the feature offers just a 5 percent overclock, and the switch doesn't let you juice up your voltage, but that protects nut cases from frying their CPUs, and maybe that's for the best.

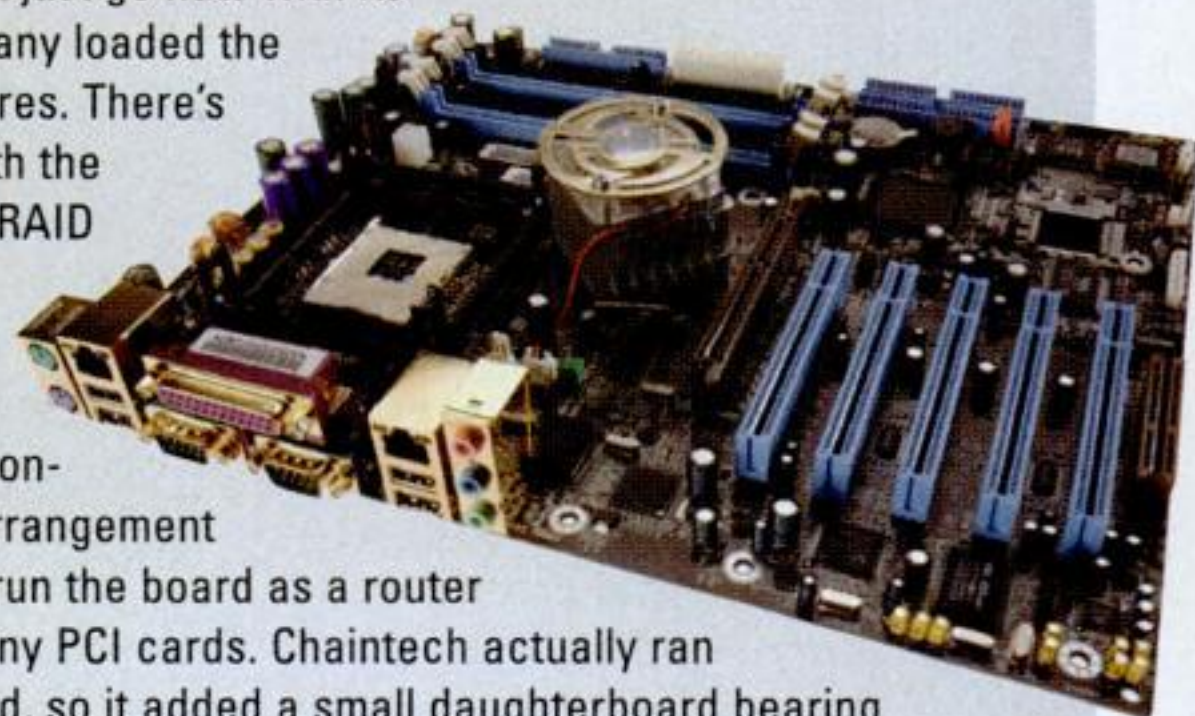


Chaintech 9CJS Zenith

Chaintech took the Ginsu knife approach with its 875P motherboard bundle: You not only get the motherboard. You get a screw driver, SATA data cables, and SATA power cables. You also get a full set of rounded Parallel ATA cables, a bay-mounted media reader, and front-mounted USB and FireWire ports. And if you order now, you also get an infrared remote control and an LED read-out that displays the POST codes as you boot!

And Chaintech didn't just go nuts with its accessories. The company loaded the motherboard with features. There's the full 875P chipset with the ICH5-R southbridge for RAID support, support for Intel's CSA LAN, and, for good measure, a RealTek Fast Ethernet controller. This dual-LAN arrangement gives you the ability to run the board as a router without having to add any PCI cards. Chaintech actually ran out of room on the board, so it added a small daughterboard bearing additional audio jacks, an optical SPDIF out, and two FireWire ports.

There's just one catch with the 9CJS. The price. The accessories aren't free, Homer. Chaintech wants you to shell out \$269 for its board. The street price will likely be lower, but that's a pretty penny for a motherboard.



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How To Pick the **BEST** **ATHLON MOBO**

Bad mobo's mean bad mojo. Here's how to pair your Athlon with the right motherboard

More than four years after the debut of the Athlon, AMD is still giving Intel—once the unchallenged king of the desktop—a run for its money. In fact, megahertz for megahertz, the Athlon still provides more bang for your buck than anything Intel has to offer. But the Athlon XP can't take on the P4 without the proper support infrastructure, so choose your motherboard wisely. As the backbone of your rig, the motherboard has the most profound effect of any component on the overall stability of your system. What's more, today's motherboards come with tons of extra features, such as built-in networking and onboard RAID controllers, that can save you

expansion slots and money.

Perhaps most importantly, the motherboard you choose today will determine what upgrades you'll be able to plug into your system tomorrow, and next year. As such, you'll want to be as informed as possible before making this critical choice—and we've got you covered. We've come up with this short list of everything you need to know about picking the right mobo for your needs, as well as reviews from our monthly mag of the two finest Athlon XP boards we've tested.

DEBUNKING THE MYTHS

Before we get started, there are a few misconceptions out there that may need to be cleared up. First of all, contrary to what Intel fanboys would have you believe, the

Athlon XP is still a perfectly viable alternative to the Pentium 4. Is the P4 faster right now? Yes, but not by a particularly large margin, and AMD still offers more bang for the buck. So if you're looking for the most performance for the least price, the Athlon XP is your processor. That said, the 32-bit Athlon series has reached the end of the line—the future lies with the imminent Athlon 64 and its 64-bit instruction set, so be forewarned that buying an Athlon XP right now won't provide you with much upgrading headroom.

There are also some popular misconceptions out there that apply to motherboards in general. Many people believe that having more PCB layers—in other words, a thicker motherboard—makes for better quality and reliability. Though this may be true in some cases, it is not a valid rule of thumb. A skilled engineer may be able to accomplish in four layers what an incompetent engineer needs six layers to do. Thus, it's not a good idea to use "more is better" as a general rule when it comes to motherboard layers.

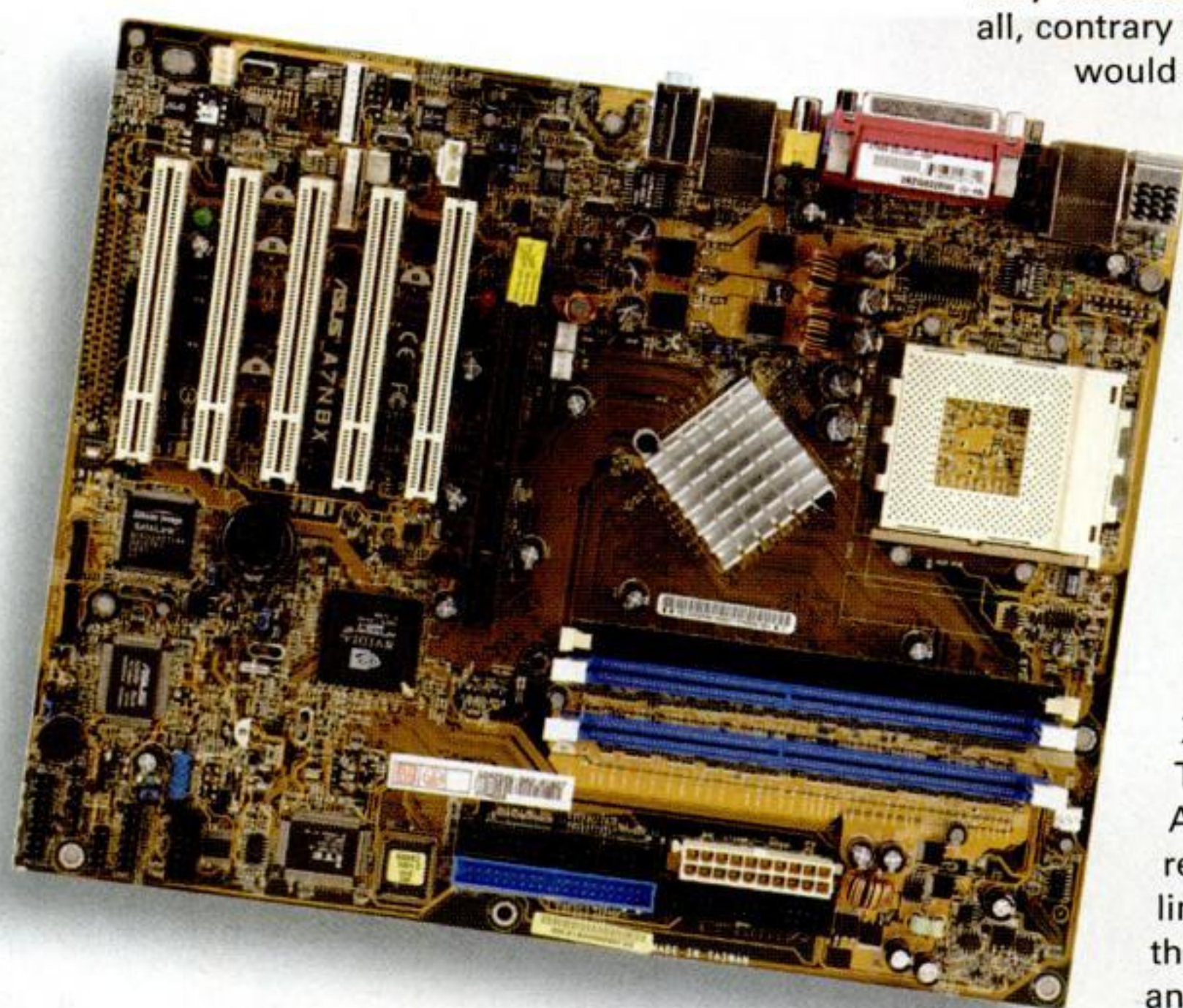
The same thing applies to capacitors, which can be thought of as tiny "storage tanks" that hold an electrical charge. The stored charge helps compensate for an uneven flow of electricity to the motherboard. While some folks think that having bigger capacitors makes a motherboard more reliable, it's not necessarily the case. As with PCB layers, more is not necessarily better, and good design in this instance isn't apparent to the naked eye.

CHOOSING A CHIPSET

The first decision you need to make when shopping for a motherboard is what chipset you want. There are really only two companies making performance chipsets for the Athlon platform today: nVidia and VIA. SiS also makes Athlon chipsets, but they tend to be targeted at the budget market, and generally aren't as refined or feature-filled as those from nVidia and VIA.

Of all the Athlon chipsets out there, nVidia's nForce2 Ultra earns our highest recommendation. The nForce2 line sports such features as built-in Dolby 5.1 audio, 10/100Mbps LAN, AGP 8x support, a dual-channel DDR400 memory controller for maximum memory bandwidth, and optional GeForce4 MX-level integrated graphics. The Ultra version adds excellent support for the 400MHz frontside bus—earlier versions of the nForce2 promised this support, but didn't deliver it consistently. If you don't care about 400MHz FSB support, though, any version of the nForce2 should give you great performance and rock-solid stability.

VIA's KT400A is the other main



The A7N8X Deluxe motherboard from Asus goes nuts with sweet features like built-in Ethernet, USB 2.0, and FireWire, all piped in through the high-bandwidth HyperTransport interconnect.

contender for the Athlon XP chipset throne. It offers DDR400 memory support, but only in single-channel configurations, and lacks 400MHz FSB support. The KT400A does include built-in networking and AGP 8x capability, but feature-for-feature it's still outclassed by the nForce2 line. The KT600 chipset will soon succeed the KT400A, boasting such amenities as 400MHz FSB support, six-channel audio, and built-in RAID support. Performance-wise, the KT600 could put nVidia and VIA neck and neck. Be forewarned, however, that VIA has a reputation for problems with stability and robustness, both of which are hallmarks of the nForce2.

Surprisingly, even if the chipset on your motherboard claims to support a certain FSB speed, that's no guarantee that the motherboard itself will support it. Some Athlon boards only offer 400MHz FSB support on certain revisions, so make sure to check the manufacturer's web site or motherboard documentation for this important feature.

Next up is memory. To maximize your performance, you'll want a board that uses a dual-channel memory controller, such as that of the nForce2. When at least two sticks of memory are installed in a dual-channel-capable motherboard, the system's effective memory bandwidth is doubled—no special type of

USB 2.0 and FireWire is important as well, so you can hook up all the latest peripherals to your rig.

Motherboards with a jumperless design are always preferable. If you catch overclocking fever someday, you'll be able to manipulate clock settings without messing around with physical jumpers.

Comprehensive thermal monitoring is another invaluable feature—you'll want a mobo that can automatically shut down your PC if the CPU overheats or its fan dies. Lastly, make sure the motherboard you want doesn't have capacitors positioned too close to the processor socket, as this can make it difficult to install a CPU cooler.

Some motherboards throw in extremely handy extras like these rear-panel brackets that give you additional I/O ports and diagnostic lights (that might help you diagnose hardware trauma).



BASIC FEATURES TO LOOK FOR

Having chosen your chipset, it's important to know what basic features to look for in a motherboard. Most important is processor support—any motherboard you buy should be able to work with the Athlon XP 3200+, the final Athlon XP to be released. The 3200+ chip runs on a 400MHz FSB (frontside bus), so this means that whatever motherboard you choose should support this bus speed as well (if your motherboard has a slower FSB, the Athlon XP 3200+ will still function, but at nowhere near its full potential).

memory is required. In general, you'll want to synchronize the speed of your memory with the speed of your frontside bus, e.g. DDR333 memory with a 333MHz FSB. So, make sure the mobo you buy supports a high enough grade of DDR for your CPU's FSB. Also, try to get a board with three memory slots; some cheapo boards offers just two.

Another basic feature you'll want to look for is an AGP 8x slot with a retention clip at the end. A retention clip is a good safety measure to have, helping to keep your videocard from coming loose in its slot over time. Support for

OVERCLOCKING FEATURES

Hoping to overclock your system to get the most from your investment? If so, there are a few additional motherboard features you'll want to look out for. For instance, the ability to adjust frontside bus speeds and clock multipliers through the BIOS is very desirable. Some mobos still use jumpers or DIP switches for this task. Even worse, others simply don't allow you to overclock at all—so make sure you're getting the real deal.

Lately, some motherboards have begun offering the ability to adjust memory and FSB speeds

independently of AGP and PCI bus speeds. If you're planning significant overclocking, this is a feature you'll definitely want to have. Traditionally, overclocking the frontside and/or memory buses resulted in the AGP and PCI buses being over-clocked as well, thus increasing the number of possible failure points. A motherboard that allows your AGP and PCI devices to run at spec even when other parts of your system are overclocked will significantly increase your chances of overclocking success.

EXTRA FEATURES

Today's motherboards are so feature-filled that it's quite possible to build a complete system without buying a single expansion card. Many once-exotic features, such as onboard networking and RAID, are practically standard fare on today's motherboards. Any motherboard you buy should at least have built-in 10/100Mbps Ethernet—though, depending on your needs, you may want to look for one with dual Ethernet ports or even Gigabit Ethernet.

Integrated RAID is another common feature, but one that's definitely not for everyone. Should you decide to spring for a mobo with a RAID controller, look for one that supports the new RAID 1.5 spec, which allows you to perform both striping *and* mirroring simultaneously with just two hard drives—a very cool feature. Meanwhile, if you want to run the new generation of 10,000rpm hard drives, make sure you get a board that boasts a Serial ATA controller.

A hard-to-find feature that might be worth seeking out is quality integrated audio. Most chipsets offer little more than crappy-sounding generic sound circuitry. However, nVidia's nForce2 can pump out some high-quality vibes, roughly matching the audio prowess of a Sound Blaster Live! card. Additionally, it features real-time Dolby 5.1 encoding and decoding. If you're planning to buy (or already own) a soundcard you're happy with, you don't need to worry about the quality of your motherboard's integrated audio.

There are also a few other features you may want to keep an eye out for. Many motherboards now come bundled with cool bonus peripherals, such as flash memory reader/writers or a remote control. In addition, some mobo manufacturers have started catering to case modders with features such as colorful PCBs or fluorescent expansion slots that look positively slick through a window. And finally, don't underestimate the value of a decent software bundle. Most mobos come with a bunch of crusty old apps that you'll never use, but some toss in a temperature monitoring program or free antivirus software, both of which are good to have on hand.

All of that should give you a pretty good idea of what to look for in an Athlon XP motherboard. Now, flip the page and check out our reviews of the two best Athlon mobos that have passed through our lab in recent months.

top picks

Asus A7N8X Deluxe

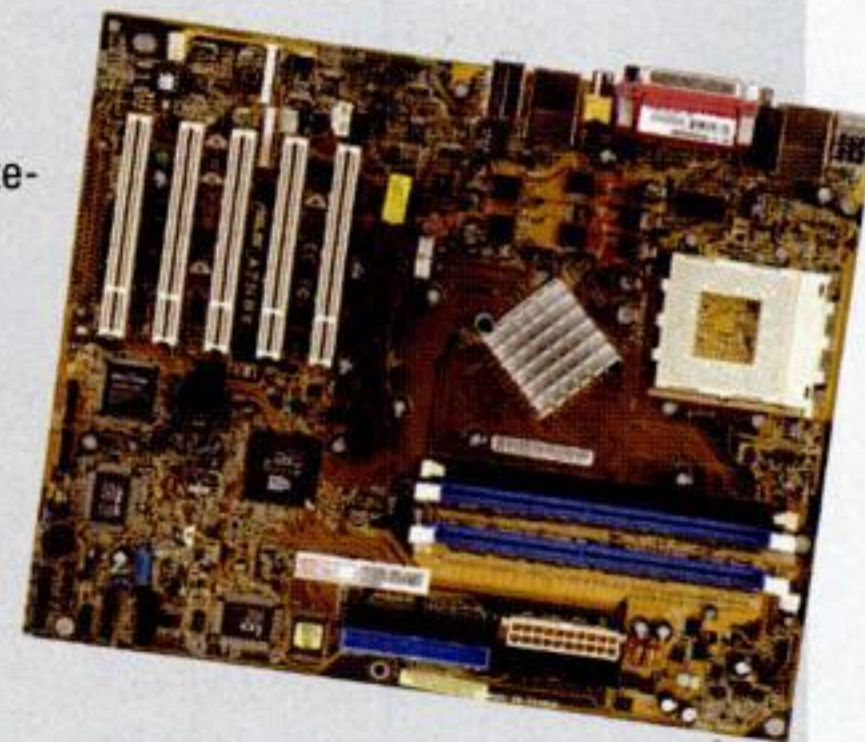
For starters, the A7N8X Deluxe takes full advantage of the nForce2's advanced integrated features. With the nForce2, your Ethernet, USB 2.0, audio, and FireWire controllers all plug directly into the chipset via the high-bandwidth HyperTransport interconnect. In theory, this should give the nForce2 superior performance when accessing network or FireWire devices, especially when transferring large amounts of data.

The Asus board's overall layout is clean, with no precariously positioned capacitors near the CPU socket. The board features an AGP Pro slot, as well as a warning LED that tells you if you've put the wrong kind of videocard in the system. There's also support for Serial ATA RAID, and not one but two Ethernet ports.

But the real story with the A7N8X is its performance. In all the benchmarks that get a boost from memory bandwidth, the nForce2 runs away from the VIA KT400.

For now, the nForce2 stands as the dominant chipset for the latest Athlon XPs. This Asus board offers a good upgrade path should AMD offer 400MHz CPUs, and it's already head and shoulders above the KT400 mobos.

Caveat emptor: Early PCB revs do not support the 400MHz FSB. Be sure to look for a Rev 2 or higher version of this motherboard to get 400MHz FSB support.



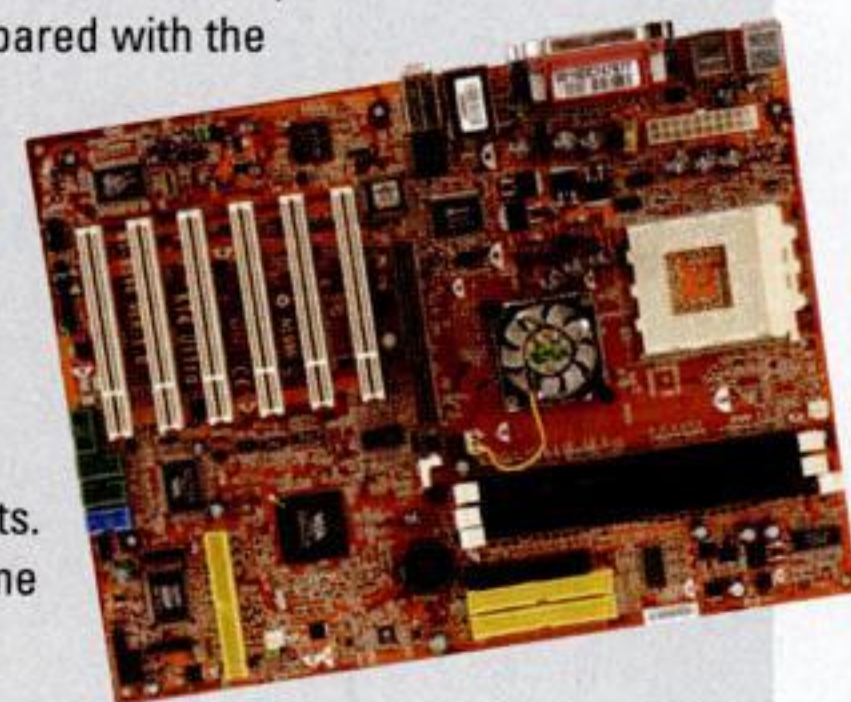
MSI K7N2 Delta-ILSR

Besides offering official 400MHz bus support, the Ultra 400 can theoretically be clocked even farther, though how far depends on your system's CPU, RAM, and power supply. Still, for overclockers, the Ultra is the label to look for.

The board sports MSI's trademark crimson finish and an interesting assortment of PlaySkool-colored connectors. The I/O options are nice for an Athlon board, but seem average compared with the Intel 875P boards' offerings. There's a Promise Serial ATA RAID chip, an onboard Fast Ethernet port (care of the nVidia MCP2-T southbridge), and two FireWire A headers. Instead of jamming up its I/O shield with sundry ports, MSI provides several rear-panel brackets for USB, FireWire, and diagnostic POST lights. This offers system builders some welcome flexibility, but if you decide to install all three rear-panel brackets, you'll need to give up three slots in the back of your rig.

As for pure core-system performance, we saw the K7N2 Delta-ILSR outperform the DFI Lan Party KT400A in just about every test. Consider this a ringing endorsement for the dual-channel memory controller in the nForce2.

We love this MSI mobo, but our review unit lacked one necessary component: a badge proudly declaring that an nForce2 Ultra 400 was soldered to the PCB. You'll want to make sure the board you buy has the goods inside.





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▶ Sound Blaster Audigy 2
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▶ Western Digital 120GB
ATA100 Hard Drive
Part#: HD-1200JB



SONY

▶ Sony CLIE SJ33
Handheld PC
Part#: SONY-SJ33



AMD

▶ AMD Athlon XP-2600
CPU 256K 333MHz Retail
Part#: XP-2600BX



D-Link

▶ D-Link AirPlus DI-624
802.11g Wireless Router
Part#: DL-DI624



MSI

▶ MSI MEGA 651
Radio/Barebone PC
Part#: MB-MEGA651



Kingston

▶ Kingston 512MB HyperX
DDR 400MHz DIMM
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Part#: DVD-DVRA06



NEC

▶ NEC MultiSync 1760V
17" LCD Monitor
Part#: NEC-1760V



Abit

▶ Abit IC7 P4(478)/875P/ATX
Motherboard
Part#: MB-IC7



Nikon

▶ Nikon Coolpix 4300
Digital Camera
Part#: NIKCPX4300



Shuttle

▶ Shuttle SN41G2
Barebone PC
Part#: MB-SN41G2



Maxtor

▶ Maxtor 6Y120LO 120GB
Ultra ATA133 Hard Drive
Part#: HD-MX120AY



CORSAIR

▶ Corsair 400MHz 512MB
DDR400
Part#: CD400512C2



Logitech

▶ Logitech Cordless
Navigator Duo
Part#: KB-NAVIDUO



Canon

▶ Canon Powershot G3
Digital Camera
Part#: CANON-PWG3



LINKSYS

▶ Linksys WRT55AG Wireless
A+G Broadband Router
Part#: LS-WRT55AG



Gigabyte

▶ Gigabyte GA-7VT600
Socket A ATX Motherboard
Part#: MB-7VT1394



ATI

▶ ATI Radeon 9800 Pro
128MB AGP Video Card
Part#: AT-98PRO_R



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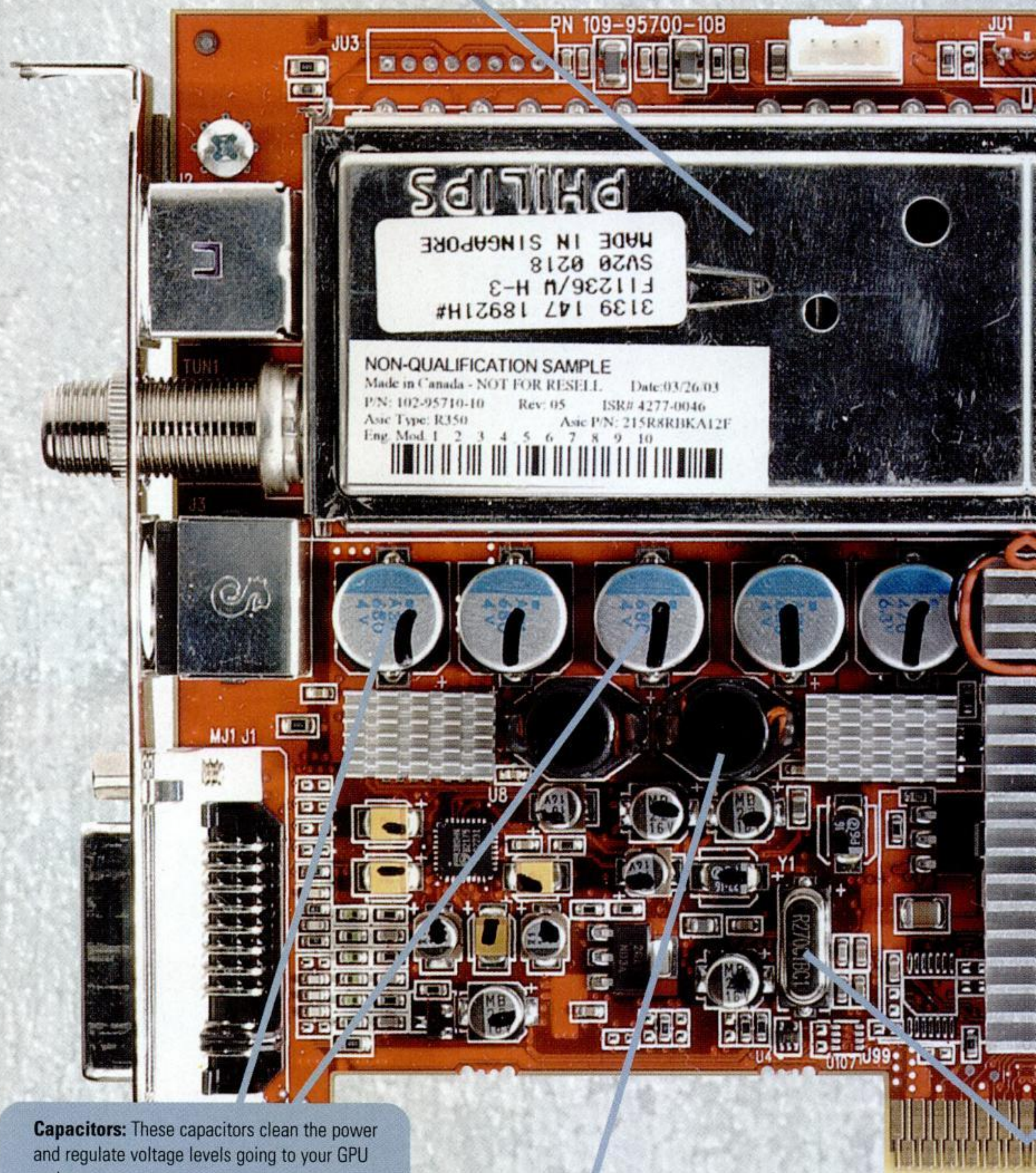


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VIDEOCARD

TV tuner: This metal box, sometimes called a "tuner can," houses an analog tuner capable of pulling TV signals from the airwaves or cable.



Capacitors: These capacitors clean the power and regulate voltage levels going to your GPU and memory.

Switching regulator: The switching regulator works in tandem with the capacitors to ensure that the proper voltage levels go to the GPU and memory.

Diodes: Handy diodes do a neat trick: They conduct electricity in only one direction. By placing them on a circuit, these diodes prevent ESD (electrostatic discharge) from damaging the videocard's sensitive components, such as the GPU. Still, they can't block every shock, so we consider the antistatic wrist strap a must every time you handle a component with an exposed circuit board. Especially the videocard—it probably cost you a bundle.

Auxiliary power connector: Scotty, we need more power! Even the AGP slot can't provide enough juice for today's enormous graphics processors that have millions and millions of transistors. This auxiliary power connector draws additional power from the system's power supply to supplement the juice provided by the AGP slot.

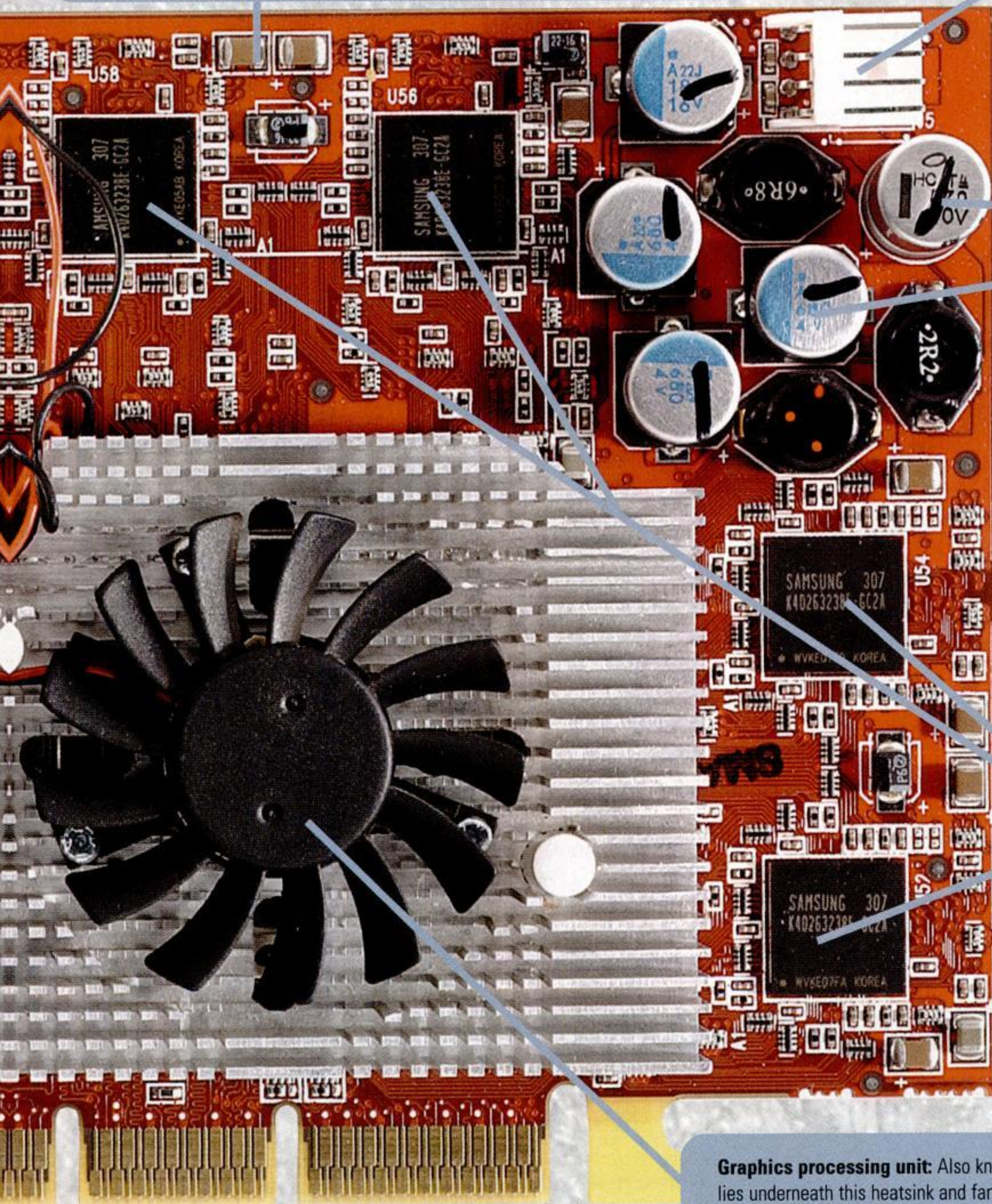
More capacitors:

These capacitors sit on the signal lines going to memory and scrub the juice of any spikes or irregularities before it's introduced into the delicate RAM modules. This clean, consistent power allows card manufacturers to crank up memory clock speeds without having to worry about shoddy power preventing the card from completing important calculations.

Onboard RAM: The graphics card's DDR memory will give the R350 processing unit anywhere from 128MB to 256MB of fast storage (the model pictured here has 128).

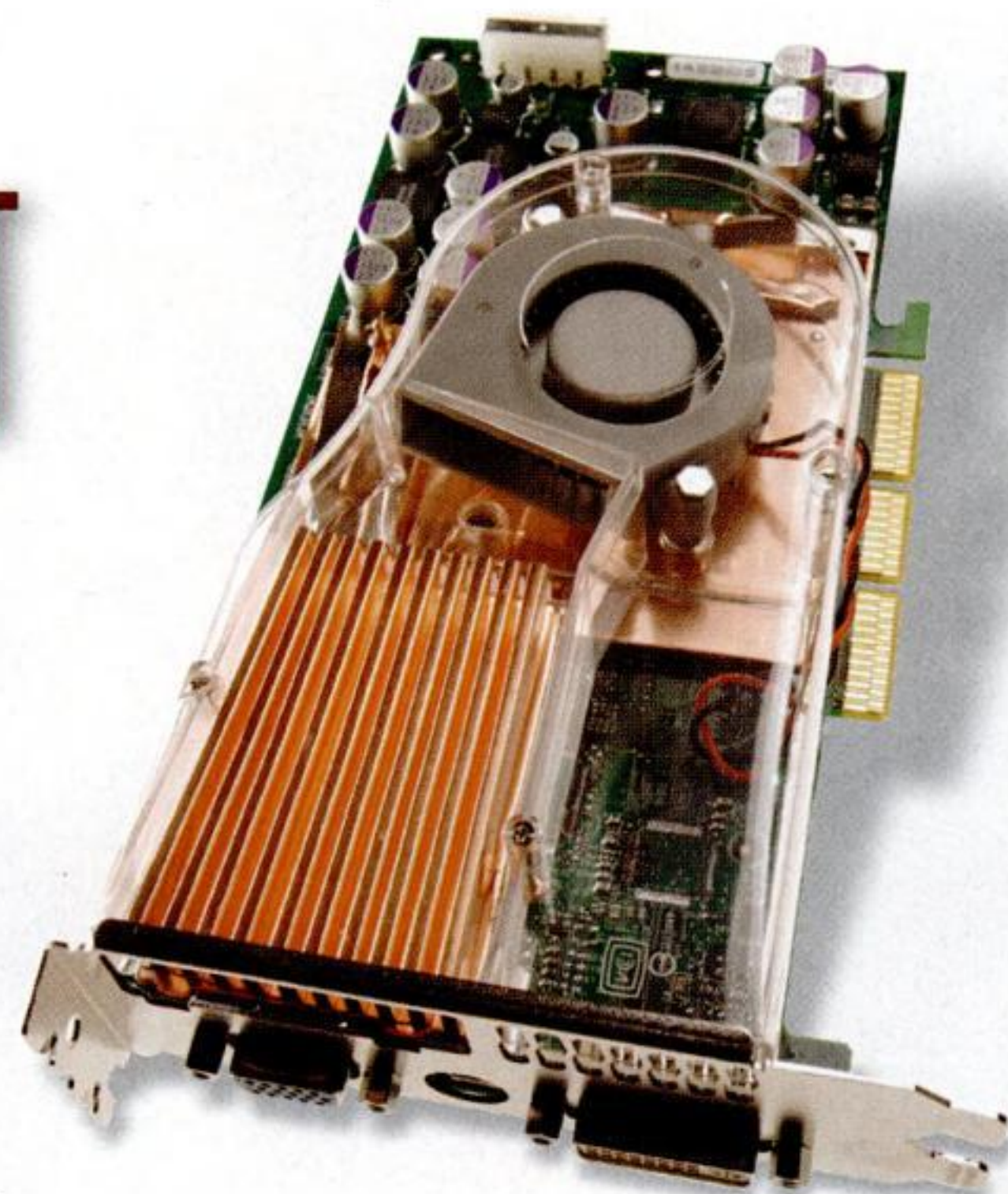
Graphics processing unit: Also known as the GPU, the whole enchilada lies underneath this heatsink and fan. The ATI R350 core is designed to perform millions of specialized graphical calculations every second. Its design is, believe it or not, far more complex than the Pentium 4 or Athlon XP.

Crystal: The crystal inside this housing vibrates at a specific frequency, providing a reference clock that controls your card's memory and core clocks (just like a quartz crystal keeps time in a watch).



How To Pick the **BEST** VIDEOCARD

It's a life-and-death decision for gamers



The GeForce FX 5800 used uber-high memory and core clocks to maximize performance, and needs a massive heatsink/fan combo to cool its chips.

The single-most important PC component for gamers—trumping even the almighty CPU—is the videocard. The videocard is responsible for drawing every polygon, texture, and particle effect in every game you play. A fast videocard will carry you into videogame nirvana, where everything runs at 60 frames per second and graphic detail is set to “Maximum.” A slow videocard will doom you to frame rate hell, where your games will resemble a slideshow.

For the uninitiated, reading the specs of a typical videocard can be a terrifying experience. But you don't have to be cowed into picking up the most expensive card on the shelf and hoping for the best. We're going to explain everything you need to know about buying the right graphics accelerator for your PC, whether you're a gamer, a graphic artist, or an evil genius. And by the time we're done, you'll know everything we know.

(At least until the next generation of videocards arrives.)

THE BASICS

At the heart of every videocard is a chip called a graphics processing unit, or GPU. Two major players design most of the GPUs suitable for gaming 3D accelerators: ATI and nVidia. Both companies sell their chips—which are significantly more complex than CPUs—to other companies, which then build the actual videocards you buy at Ye Olde Videocard Shoppe. These boards are generally labeled with either the ATI or nVidia logo. (ATI also sells its own ATI-branded boards.)

If somebody tells you that one company's GPU is superior, take that advice with a big fat grain of salt, because the technologies each company deploys are leapfrogging over each other constantly. In fierce competition with each other, ATI and nVidia release new versions of existing chips at least every six months, with entirely new chip generations appearing every year to 18 months. As

a result of these grueling product cycles, the fastest card can change three, four, or even more times a year.

There are two different types of videocard interfaces inside your PC. The accelerated graphics port (AGP) is designed specifically for 3D accelerators, which require massive data transfers between the videocard and the rest of the system. The other interface is the classic PCI slot that your other cards use (soundcard, network adapter, etc.). Because PCI slots aren't capable of transferring graphics data as fast as AGP slots, you'll want to avoid buying a PCI videocard unless it's absolutely necessary. Your motherboard, for instance, may have a videocard built into it and not have any AGP slot at all. If this is the case, we recommend upgrading to a better motherboard if you're up to the task.

REGULAR OR EXTRA STRENGTH?

There is a wide price range for videocards. For the most part, all the cards from the same vendor (ATI or nVidia, for example) use the same basic chip, but performance-enhancing functions are disabled as the cards get cheaper. The highest-end cards are priced between \$400 and \$500, and have more memory and higher clock speeds than anything else on the market (we'll talk about what those specs mean in the next section). These are the brawniest of the videocards, capable of drawing more polygons at higher resolutions and higher frame rates than anything else at the consumer level.

In the \$300 range, the boards are generally based on the same basic chip as the hyper-expensive cards, but have less onboard memory or have features intentionally disabled to slow them down. Videocards priced in the \$200 range generally have less memory and are even more crippled than the \$300

cards, but still include the same basic functionality as the \$500 cards. Generally, cards under \$200 are at least one generation old, include even less memory, and are significantly slower than the other cards.

What you sacrifice by purchasing a \$200 card versus a \$500 card varies from manufacturer to manufacturer, but speed is virtually always the first victim. Read on to understand why.

CLOCK SPEEDS

Just about every component in your PC has a “clock” speed, including your videocard. In fact, there are two different clocks on the videocard. One controls the speed of the GPU, while the other sets the speed of the memory. The GPU clock is called the “core” clock, and the other is called the “memory” clock. Increasing the core clock ups the number of calculations the GPU can do every second, while adjusting the memory clock changes the bandwidth, or amount of data the memory can transfer to the GPU every second. If everything else is equal, a card with faster core and memory clocks will be faster than a card with slower clocks.

Even though high-end videocards use the same basic core as cheap videocards, GPU cores that will run at the requisite super-high speeds are rare. Only a small percentage of GPUs can run at the 400MHz+ speeds required by

a high-end videocard. Memory is much the same. System memory that's in most PCs runs somewhere between 100MHz and 200MHz—one MHz, or megahertz, is one million memory transfers per second. The memory on high-end videocards runs at 500MHz. Memory this fast doesn't come cheap.

The easiest way for a GPU manufacturer to slow down a videocard is to lower the core and memory clocks. The default clocks for each card are programmed on a BIOS chip that's soldered to the motherboard, but those clock speeds are easy to adjust by an adventuresome end-user. Using an application like *Powerstrip* (www.entech.co.tw), it's easy to overclock most videocards' GPU and memory. But overclocking isn't for everyone. It can create heat-related visual glitches in your games, jeopardize your machine's stability, and even permanently damage your videocard if it isn't properly cooled. You've been warned.

MEMORY BANDWIDTH

The amount of data your card can move between the GPU and the videocard's onboard memory (called memory bandwidth) is the biggest bottleneck on the videocard. The memory bandwidth is controlled by three things, the memory clock, the size of each 'chunk' of data transferred every clock cycle, and the number of chunks of data transferred

each cycle.

The GPU reads and writes small chunks of data to the memory almost a billion times per second. Right now, most videocards use double data rate (DDR) memory. DDR memory can transfer two chunks of data every clock cycle instead of just one. (The type of memory supported by a board is configured at the chip level, and it's not user configurable.) In addition to original DDR memory, which is in wide use now, there are also newer DDR-II and G-DDR memory specs. DDR-II is designed to run at much higher clock speeds than vanilla DDR and will be used for main system memory and some videocards. G-DDR (or graphics DDR) memory is designed specifically for videocards, but it's not available yet. When it is, we expect it to become the standard on high-end videocards. It doesn't require as many extra components soldered on the graphics board, and it runs at higher clock speeds than even DDR-II. We don't expect to see any videocards equipped with anything other than one of these flavors of DDR memory going forward.

GPU manufacturers design their chips to accommodate specific-size chunks of data; this isn't user configurable either. The size of the data chunks is also referred to as the width of the memory pipeline. A wider pipeline means more memory bandwidth for the GPU. Most high-end cards today transfer 256-bit chunks of data at a time, while budget boards transfer just 128-bit or 64-bit chunks. It's always best to get a card with the widest pipeline possible. You can always overclock your memory to make it faster, but you can't adjust the width of the memory pipeline on most cards. There are some hardware hacks that enable wider pipelines on some videocards, but this is the exception, not the norm.

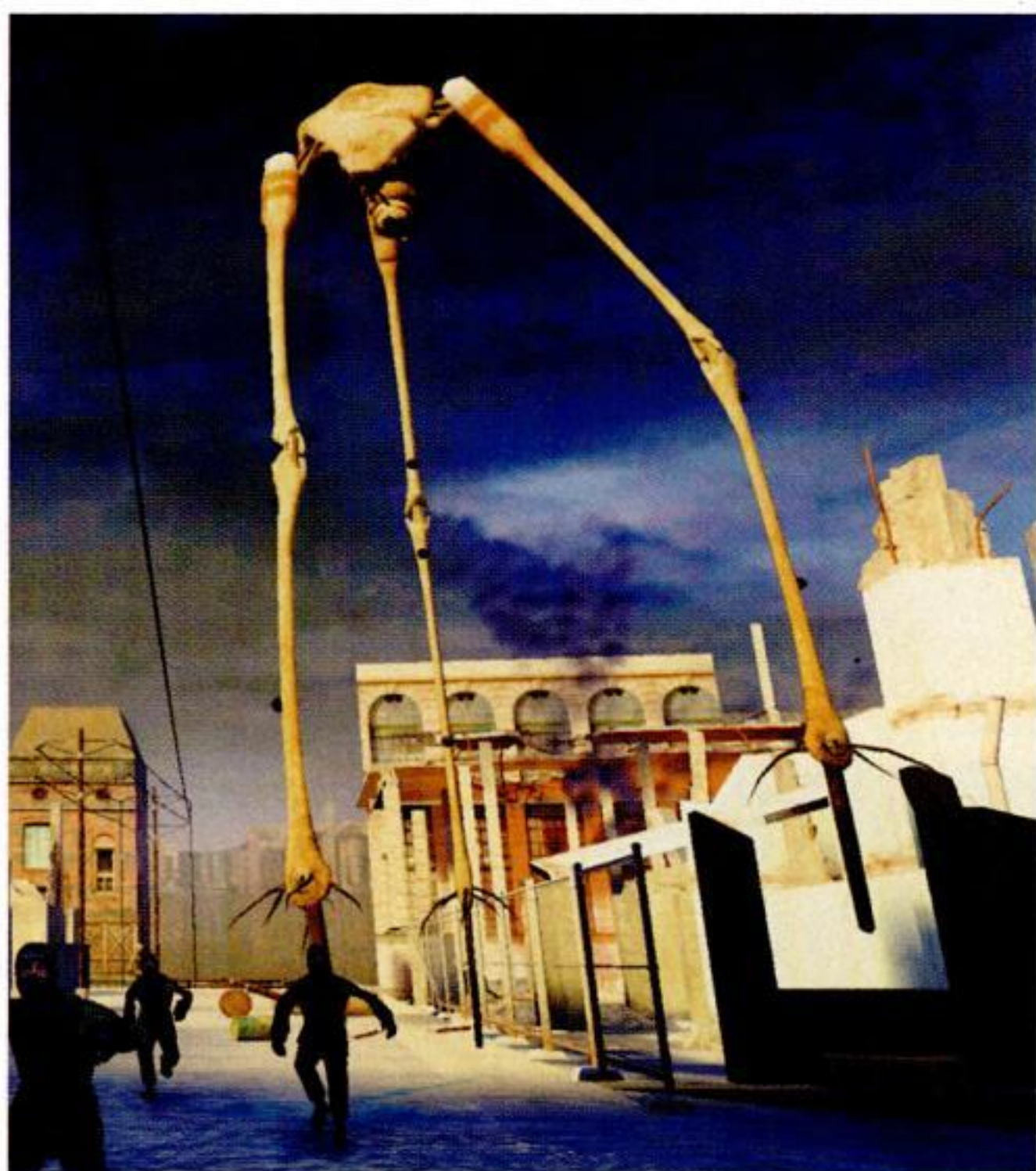
MEMORY SIZE

The fastest memory in the world won't do you any good if there's not enough of it to hold all the data your games and applications will toss at it. Even crappy-looking old games can fill a 64MB card's onboard RAM, and when that happens, the game will

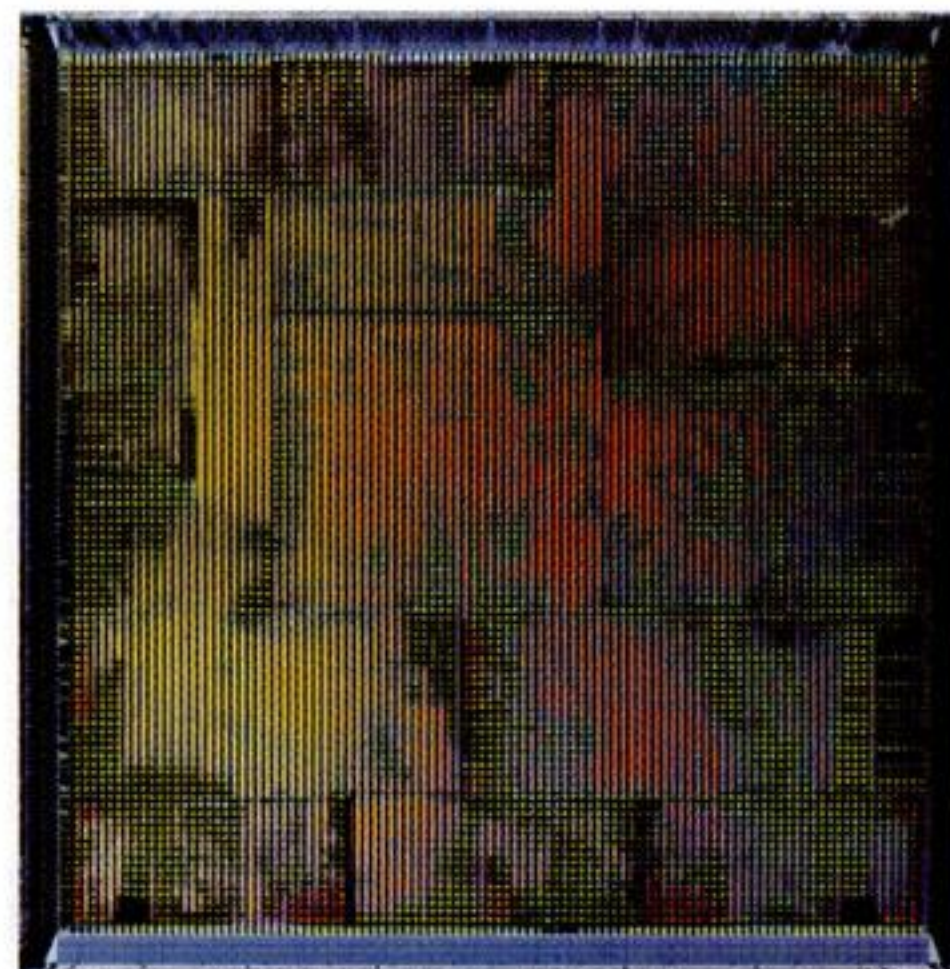
have to store its data in your significantly slower system memory. As a result, your frame rates will tank.

Games use onboard memory to store both the textures and models that make up a 3D scene, and the work in progress as an image is rendered. Modern GPUs read and write to video memory just like a CPU does with system memory, but video memory is an order of magnitude faster than the memory the CPU has to work with. Where even the fastest system memory can only transfer 2GB/sec, video memory on a high-end card can transfer more than 20GB/sec of data.

We recommend a minimum of 128MB of RAM for optimum results in most games. People who primarily favor single-player games can probably get by with 64MB, but online multiplayer gamers need as much video memory as possible. Even 256MB isn't out of the question. Consider going with less than 64MB of RAM only if you don't intend to play any games at all.



Half-Life 2 will use programmable shaders to make every surface in the game look more real. It will bring old 3D cards to their knees.



The GPU is the heart of your 3D accelerator. It's responsible for drawing, texturing, and lighting everything 3D on your PC.

GPU ARCHITECTURE

Memory bandwidth is an important part of the videocard speed equation, but the inner workings of the GPU have a lot to do with it too. To understand how GPU architecture affects performance, you need to understand a bit about how 3D accelerators work.

The image displayed on your monitor is made up of many tiny dots of color called pixels. The 3D accelerator has to draw each pixel and form them into a single frame, which is then displayed on the monitor. This has to happen at least 30 times a second to create

the illusion of motion.

Drawing individual pixels isn't a simple process. To draw a 3D scene, the videocard first determines the shape of the world from the program that's running, then it draws wireframes out of polygons. At this point, the hardware T&L (transform and lighting) engine converts the polygon-based wireframes into individual pixels that make up the scene. After that, textures are applied to each pixel. For example, a wall might get a stone texture applied to it, while a human model will get a skin texture. More advanced techniques, like bump maps, are then applied to the textures to make them look less flat and more real (a bump map would help the stone wall look rougher, more dimensional, and realistic). If the pixel being drawn is behind glass or fog, those effects are blended in too. Finally, any lighting calculations are performed and applied to the texture. In today's games, each pixel can sometimes have 12 or more effects applied to it!

To speed up this process, modern 3D accelerators can process more than one pixel at a time. High-end 3D cards sport four or even eight pipelines capable of applying one texture or effect to a pixel per clock cycle. Because 3D accelerators perform the same functions over and over for millions of pixels each frame, adding extra pipelines makes them significantly faster. Budget cards usually have just two or four pipelines.

PROGRAMMABLE SHADERS

An important advance of the last two generations of videocards are programmable

shader units, which let developers create much better looking games. Before programmable shader cards were introduced, the fixed-function 3D pipeline was highly specialized. Although it worked much faster than a more general-purpose processor, such as a CPU, it was also extremely inflexible.

Programmable shader units make GPUs more CPU-like. In addition to the basic 3D tasks that fixed-function cards perform, shader units can execute shader programs that run complex algorithms on pixels, which are similar to regular computer programs. These shader programs can be thousands of instructions long and calculate everything from the lighting for an entire scene to the reflections in a simple mirror.

Like everything else we've talked about, high-end videocards will have the most powerful, most flexible shader units. These days, even sub-\$200 videocards support rudimentary shader programs, but to run upcoming shader games (like *Half-Life 2* and *Doom3*) at reasonable resolutions and frame rates, a high-end card is necessary.

DRIVERS

In the early days of 3D accelerators, different hardware manufacturers wrote customized drivers with special features—including exhaustive monitor databases and support for funky 3D glasses. Now driver development is too onerous a task for a mere board vendor. Drivers that used to take small teams a few weeks to write, now take massive teams of a hundred or more people several months to complete. Board vendors just don't have the resources to do much

more than add their logo to a driver. The practical upshot is: If you want the most up-to-date, reliable driver, you should go to your chipset's vendor, *not* the board vendor. Driver updates are easily accessible from www.ati.com and www.nvidia.com.

THE WORKSTATION QUESTION

We're frequently asked if professional-level workstation videocards are faster than consumer-level gaming cards. For a long time, it was true that workstation boards, which cost thousands of dollars, would provide faster frame rates in early 3D

games, such as *GLQuake*.

That's not the case anymore. Modern workstation boards are based on the same chipsets as the consumer boards, but those consumer boards are usually significantly faster than their workstation kin. Consumers need speed for games, but workstations need precision and accuracy above all else. Besides, most pro-level applications are much less intensive than even an old game. One thing hasn't changed: Workstation boards are significantly more expensive than consumer parts, starting at about \$500. People who shell out the additional scratch for a pro-level part usually get 24/7 customer support—including help for specific apps—and drivers guaranteed to work perfectly with CAD and content creation applications.

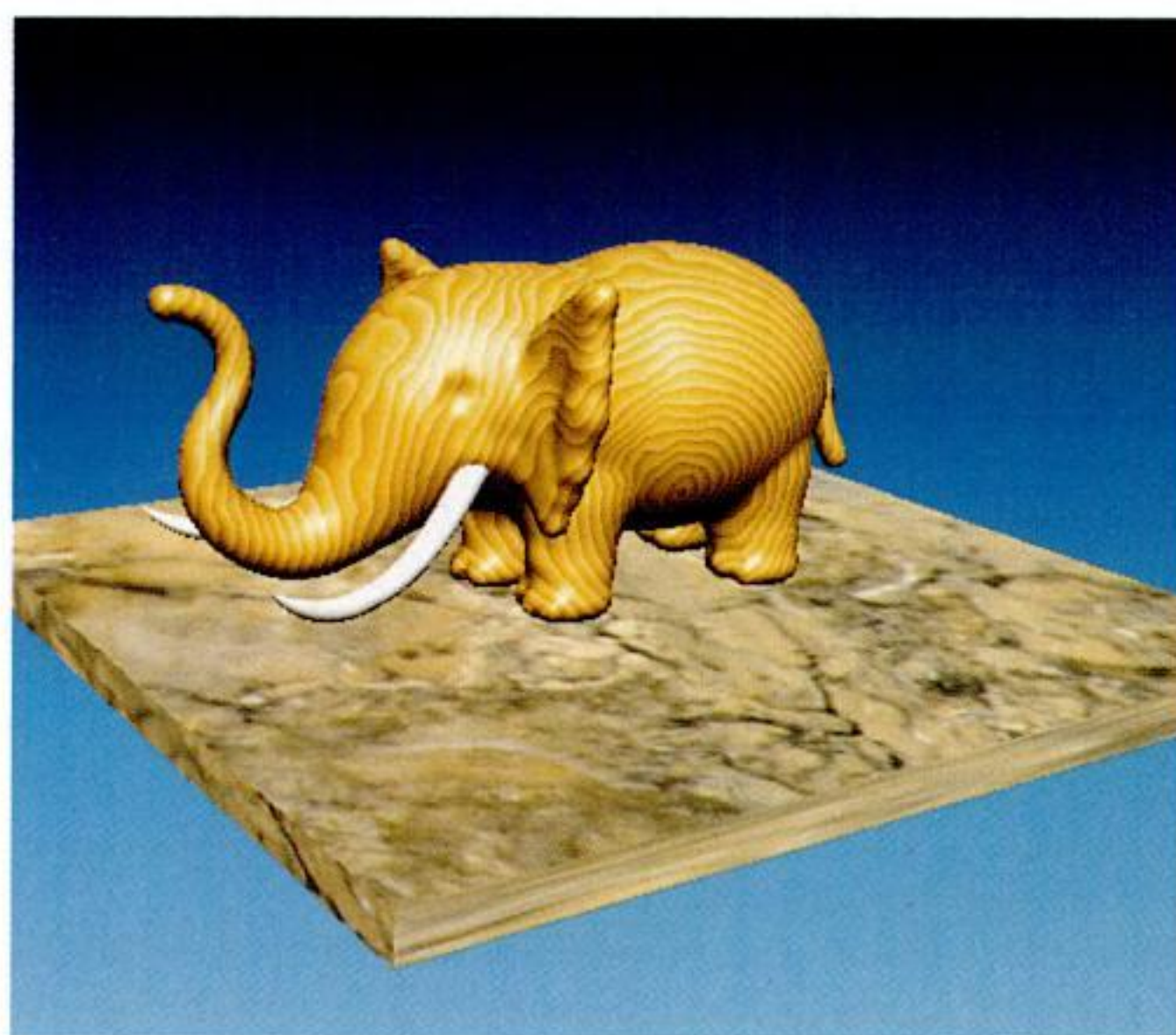
GENERAL GUIDELINES

We can't give hard and fast rules for videocard purchases because the market changes so quickly, but we can give soft and slow suggestions to help you make a more informed decision.

For gamers who infrequently upgrade their videocard, it makes sense to spend the money for a high-end videocard. A \$400 investment now gets you a card that's damn fast and will continue to perform acceptably for two or more years. As a general rule, high-end boards don't overclock terribly well, though. Overclockers can find great deals in the \$150 price range, if they don't mind slightly more frequent upgrades. Non-gamers needn't shell out the big bucks for great 2D performance. There's no reason to pay big for all that 3D research and development if you don't play PC games, and even the cheapest 3D cards are extremely fast 2D accelerators.

We're starting to see some specialty cards designed for people who spend a lot of time manipulating large digital images. Creative Labs announced a new Graphics Blaster Picture Perfect board based on a 3Dlabs workstation chip that claims to be significantly faster than a standard videocard when manipulating large image files. The board is available for about \$150. We think the image manipulation sounds cool, but we're concerned that these cards won't be able to handle even minor 3D applications.

Read on for reviews of our favorite videocards. These reviews are accurate as of mid-July, but things may have changed since then. The videocard market changes *rapidly*, so you may want to check out the latest issue of *Maximum PC* before you make a purchase.



This pachyderm's textures weren't made in *Photoshop*. His skin (and the marble pedestal on which he stands) are dynamically textured with shader programs.

top picks

nVidia GeForce FX 5900 Ultra 256MB

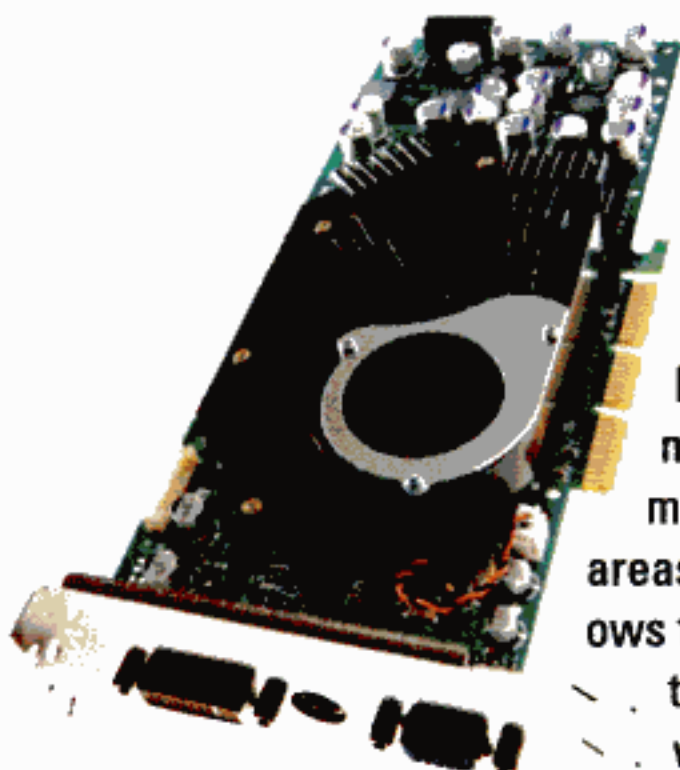
The 5900 Ultra is powered by the NV35 core, an upgraded version of the

HIGH-END

NV30, which powered the GeForce FX 5800 and 5800 Ultra. Although the double-wide 256-bit memory interface is responsible for most of the NV35's performance gains, the new core includes several other enhancements. New shadow-rendering techniques maximize performance by running the complex math calculations to draw shadows only in areas where it's physically possible for shadows to be. nVidia has also improved many of the image quality problems we experienced with the 5800 boards.

In short, the 5900 Ultra is everything the NV30 should have been, and more. Like the 5800 Ultra, it has full DirectX 9 support, including 128-bit floating point color, but the 5900

Ultra is significantly faster, especially when running bandwidth-intensive features like AA and aniso.



BENCHMARKS

	noAA/no aniso	4xAA/8x aniso
3DMark 03 Overall	5983	3529
Quake 3	154.4	7.8
UT2003 Flyby	154	83.6

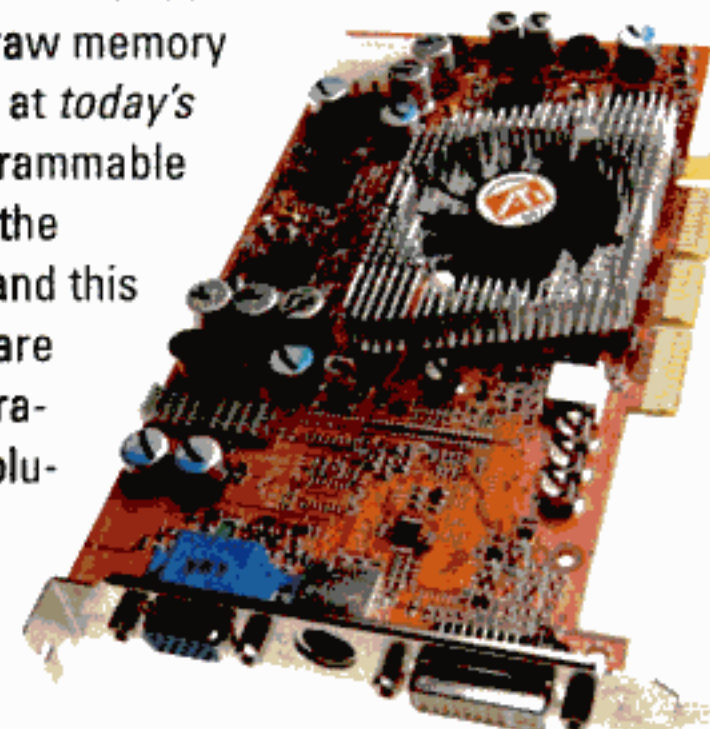
All benchmarks are run on our Pentium 4 3GHz test rig. Everything is run at 1600x1200 in 32-bit color except for the 3DMark2003 tests, in which we use the default settings.

ATI Radeon 9800 Pro 128MB

Hands down, the nicest thing about the 9800 Pro is that you can run most of today's games with all their detail settings cranked to the max. The Radeon 9800's 8-pixel pipelines and 21.6GB/s of raw memory bandwidth don't just help the card excel at today's 3D applications, though. The 9800's programmable shaders are fully compliant with both of the DirectX 9 programmable shader specs, and this ensures future game compatibility. Prepare yourself for bump-mapped everything, gratuitous use of reflective surfaces, and volumetric shadows for every single model. You'll also have complete support for full 128-bit floating point color, which helps minimize artifacts caused by rounding errors and the imprecision that results when blending integer-based colors.

HIGH-END

The 9800 Pro sports both a DB-15 analog VGA jack and a DVI inter-



BENCHMARKS

	noAA/no aniso	4xAA/8x aniso
3DMark 03 Overall	5532	2655
Quake 3	147.5	82.1
UT2003 Flyby	135.3	75.9

All benchmarks are run on our Pentium 4 3GHz test rig. Everything is run at 1600x1200 in 32-bit color except for the 3DMark2003 tests, in which we use the default settings.

face suitable for flat-panels, as well as a standard S-video out, and a component output option suitable for use with HDTVs.

ATI All-in-Wonder 9800 Pro

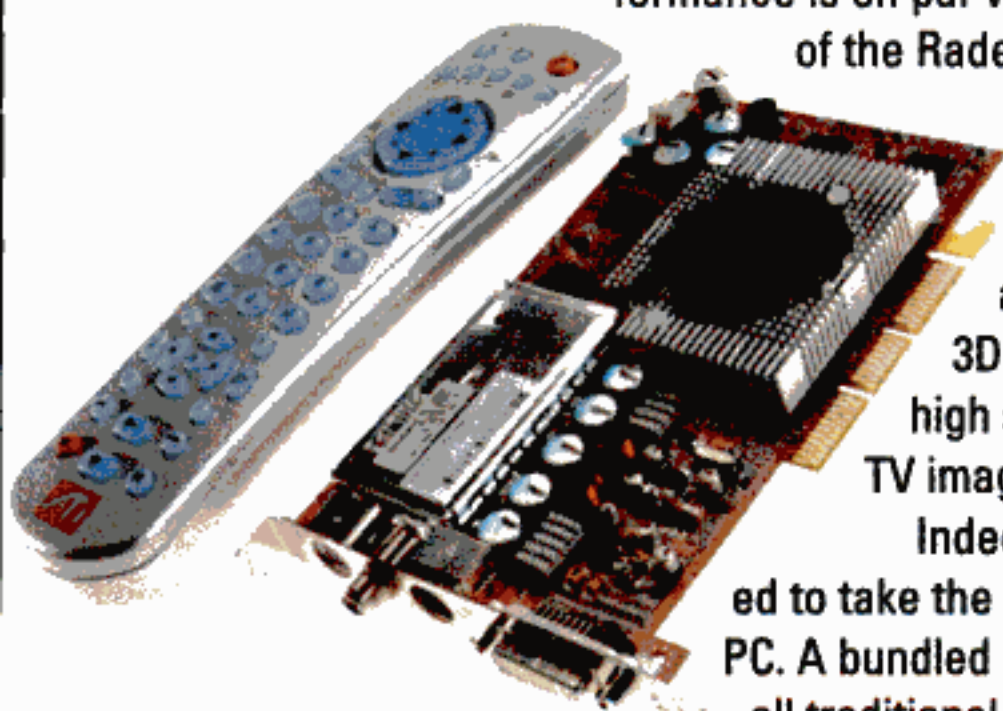
The All-in-Wonder 9800 Pro is the only option if you want fast 3D acceleration and TV viewing features in the same AGP slot. The card's per-

TV/MULTIMEDIA

formance is on par with the initial 128MB version of the Radeon 9800 Pro, which isn't surprising because this AiW runs the same 380MHz core and 330MHz DDR memory as that board. Image quality in 3D games is up to ATI's usual high standards, and the quality of TV images is excellent as well.

Indeed, the new AiW is well-suited to take the center seat in a home theater PC. A bundled remote control easily handles all traditional mousing duties and most of the common tasks you'd need while couch surfing. The bundled *Multimedia Center* app includes a "10-foot interface," designed to be visible from 10 feet away. Add to this

Multimedia Center's versatile and user-friendly TV-recording capabilities, and you've got yourself a winner.



BENCHMARKS

	noAA/no aniso	4xAA/8x aniso
3DMark 03 Overall	5778	2834
Quake 3	148	85.7
UT2003 Flyby	136	78

All benchmarks are run on our Pentium 4 3GHz test rig. Everything is run at 1600x1200 in 32-bit color except for the 3DMark2003 tests, in which we use the default settings.

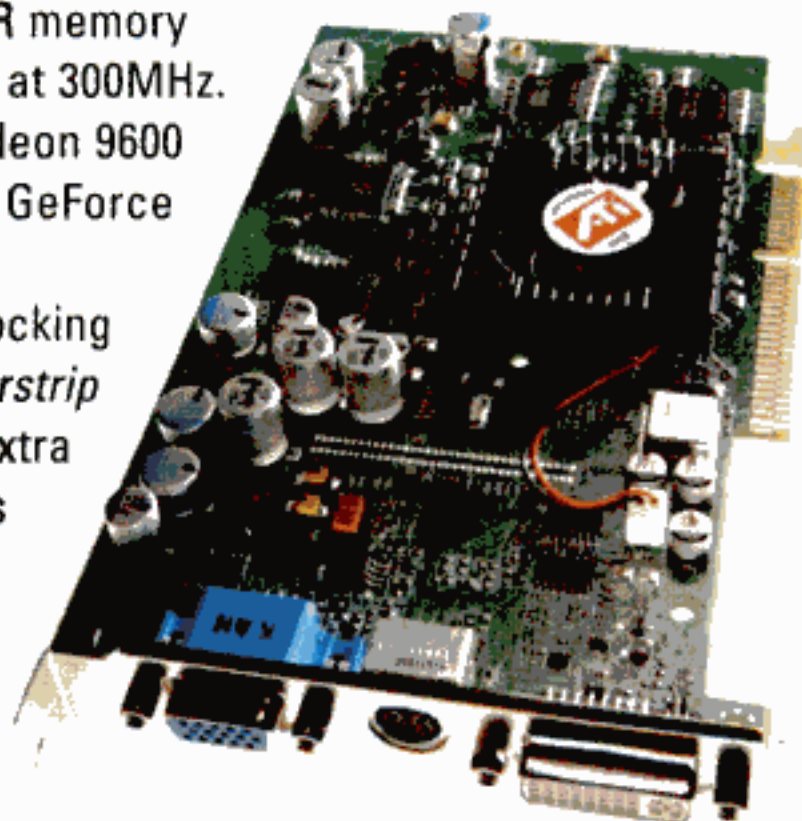
ATI Radeon 9600 Pro

The Radeon 9600 Pro is based on ATI's RV350, a modified 0.13-micron version of the R300 core used by the Radeon 9800 Pro. The GPU is clocked at 400MHz, while the 128MB of DDR memory rides a 128-bit pipe, and is clocked at 300MHz. At its default clock speeds, the Radeon 9600 offers better performance than the GeForce FX 5600 Ultra.

Plus, this card has major overclocking potential. With a utility called *Powerstrip* we were able to push the core an extra 150MHz! The memory didn't have as much headroom, but we got it running at 350MHz without any visual artifacts. If you add an aftermarket cooler and maybe even some memory heatsinks, you might be able to take your 9600 Pro even farther.

BUDGET

The card doesn't include any fancy video-inputs, but it does feature an S-video output.



BENCHMARKS

	noAA/no aniso	4xAA/8x aniso
3DMark 03 Overall	3283	1523
Quake 3	85.5	43.1
UT2003 Flyby	63	25.1

All benchmarks are run on our Pentium 4 3GHz test rig. Everything is run at 1600x1200 in 32-bit color except for the 3DMark2003 tests, in which we use the default settings.

SOUND CARD

TAD: For about 10 minutes in the early 1990s, some people thought it would be clever to use their \$4,000 PCs as telephone answering machines. This connector hooked your internal dialup modem to your soundcard for that purpose.

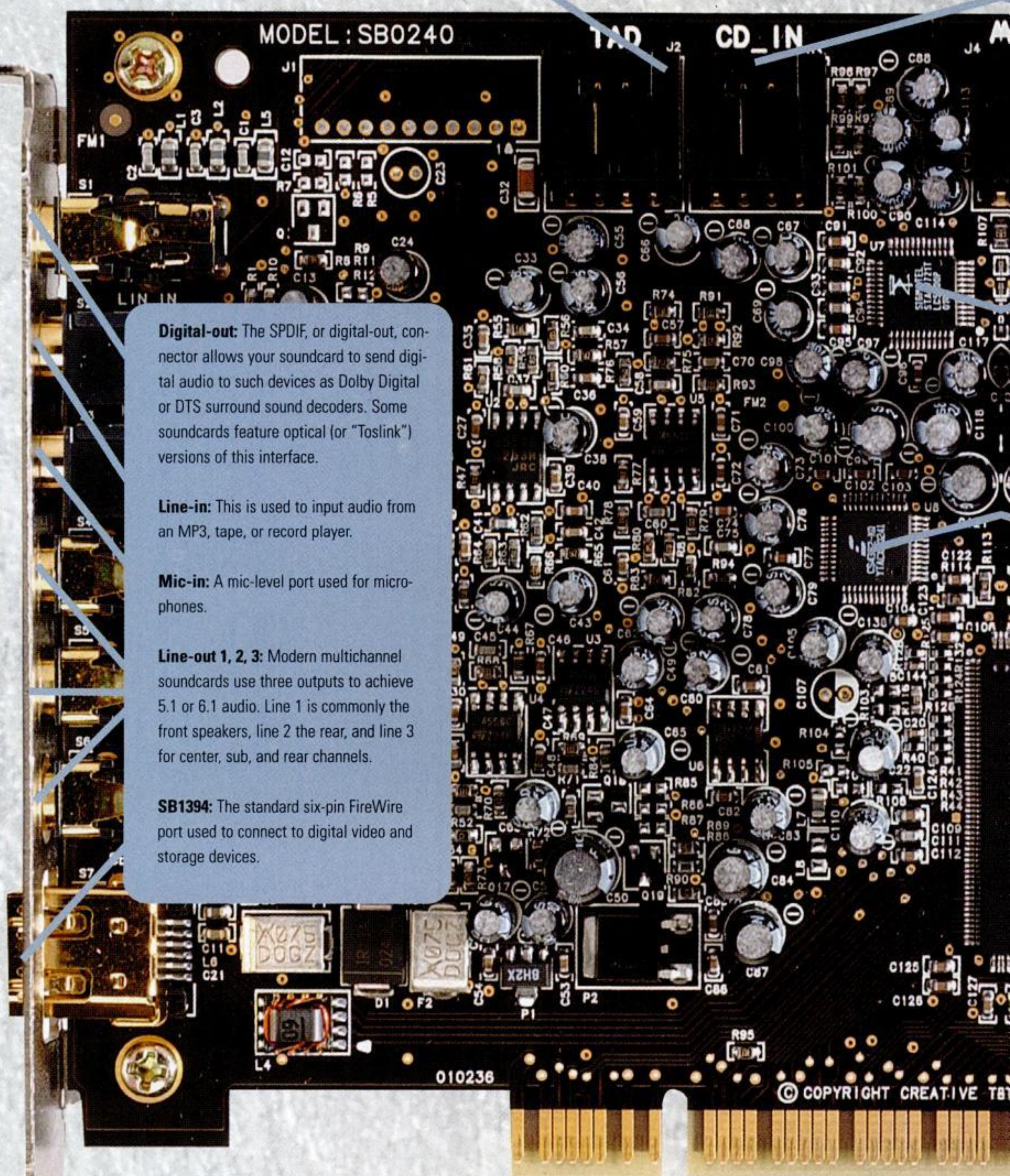
Digital-out: The SPDIF, or digital-out, connector allows your soundcard to send digital audio to such devices as Dolby Digital or DTS surround sound decoders. Some soundcards feature optical (or "Toslink") versions of this interface.

Line-in: This is used to input audio from an MP3, tape, or record player.

Mic-in: A mic-level port used for microphones.

Line-out 1, 2, 3: Modern multichannel soundcards use three outputs to achieve 5.1 or 6.1 audio. Line 1 is commonly the front speakers, line 2 the rear, and line 3 for center, sub, and rear channels.

SB1394: The standard six-pin FireWire port used to connect to digital video and storage devices.



CD-in/aux-in/CD SPDIF: CD-in and aux-in were used for analog audio playback from your optical drive and other multimedia devices (such as TV tuners). CD SPDIF introduced a cleaner digital connection to your optical drive. When manufacturers figured out how to pull digital audio through the IDE cable, all three connectors became instantly obsolete. "Buh bye."

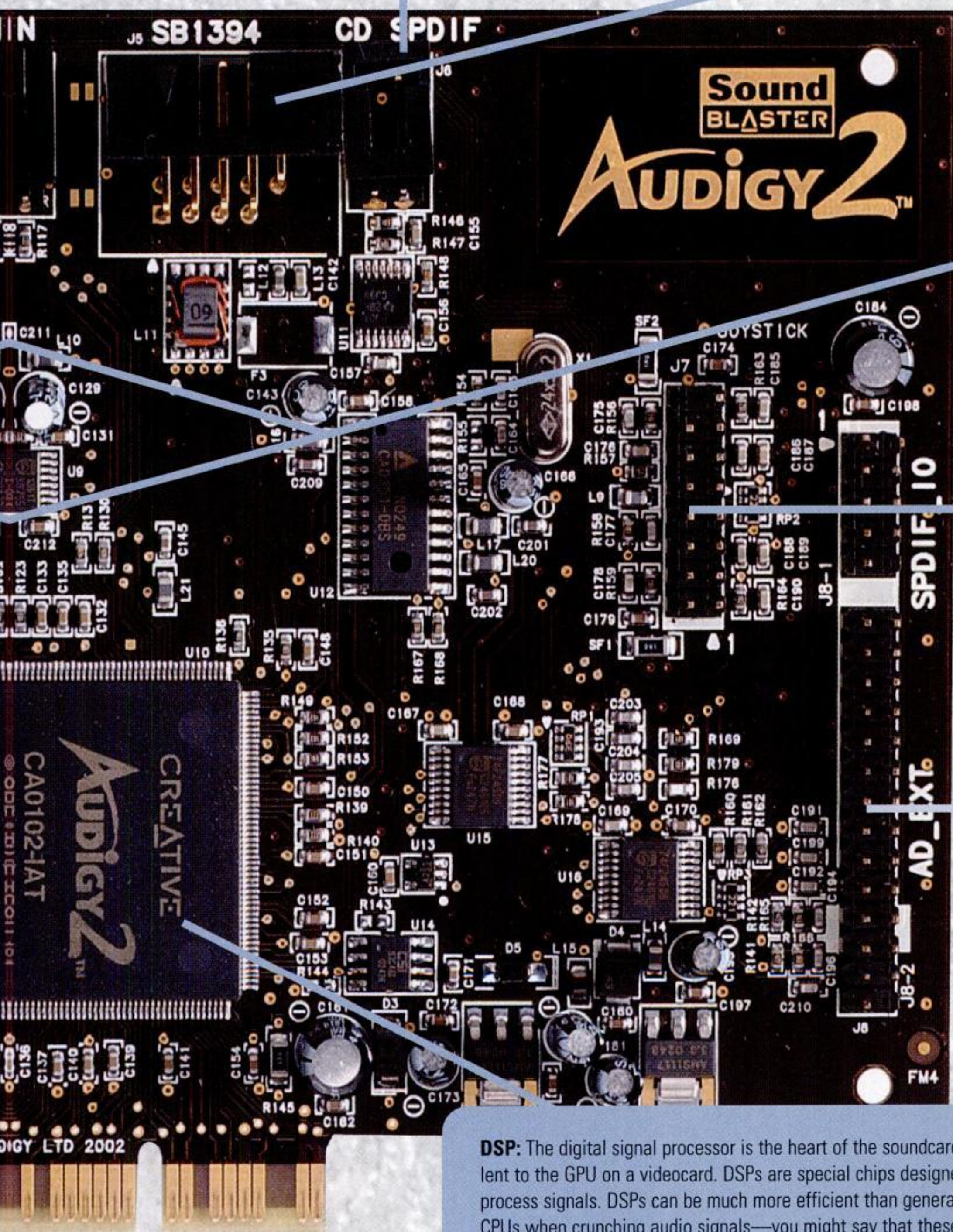
SB1394: Creative gave soundcards a cool twist when it began embedding IEEE 1394 or "FireWire" into its soundcards. These six-pin ports can be used to connect with DV cams, iPods, and other storage devices. This internal header brings a FireWire port to the front of your case.

DAC: The second-most important chip on any soundcard is the digital analog converter. Its job is to convert the digital sound the computer understands to analog that you can hear. The Audigy 2 features a Cirrus Logic CS4382 chipset which supports 24-bit audio in multiple channels. The second Sigmastar chip functions as an analog mixer for the CD, line-in, mic, and aux-in ports on the board.

Joystick header: In the unlikely event your joystick uses the old-fashioned game port instead of USB, this header allows you to add a joystick/MIDI port to the back of your PC.

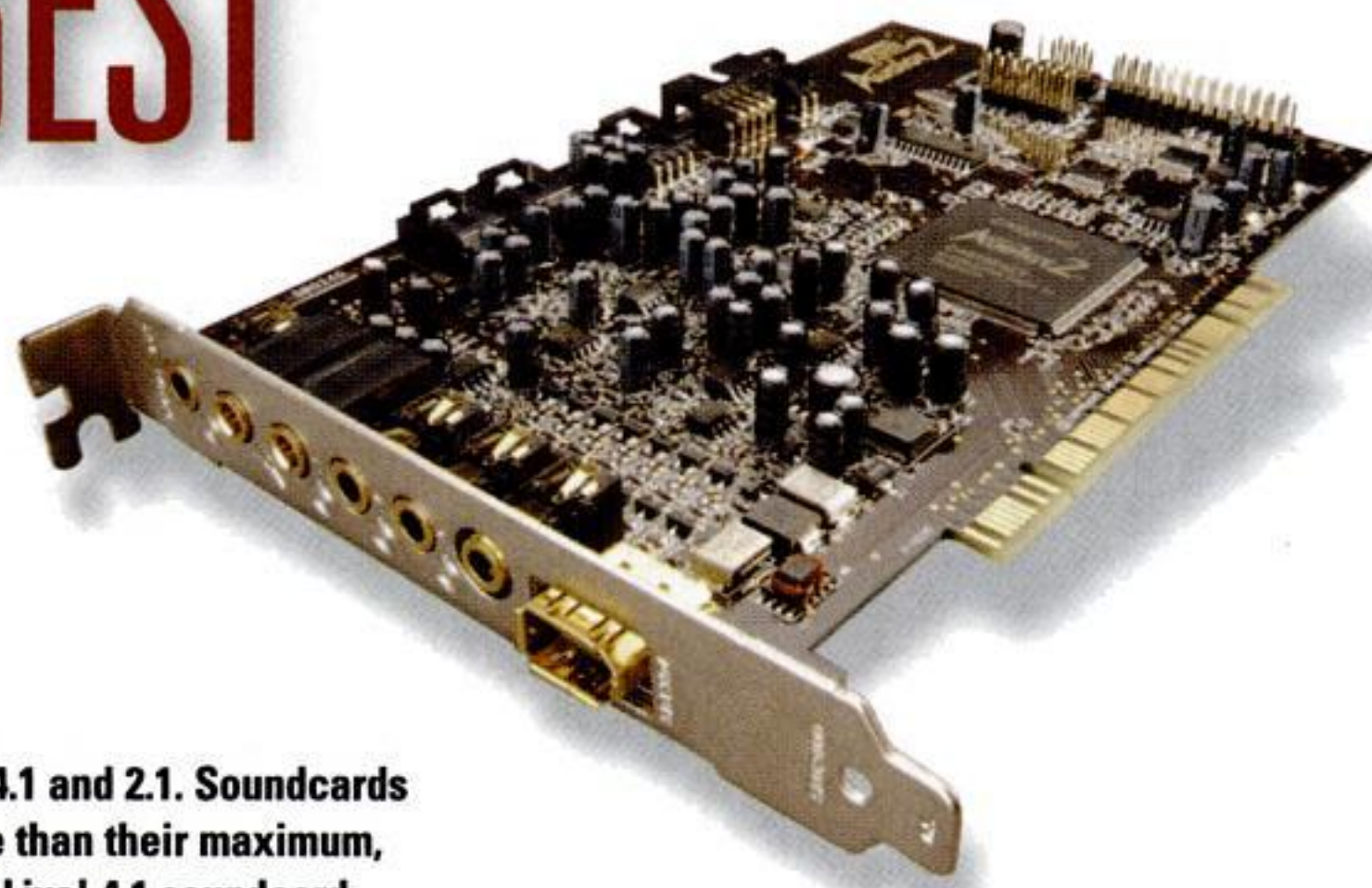
AD EXT / SPDIF_IO: This port is used to plug the Audigy 2 drive into the soundcard, which adds front-mounted optical, FireWire, analog I/O, and MIDI ports to the card.

DSP: The digital signal processor is the heart of the soundcard, the equivalent to the GPU on a videocard. DSPs are special chips designed to, well, process signals. DSPs can be much more efficient than general purpose CPUs when crunching audio signals—you might say that these chips are "trained" to do audio processing tasks very quickly. The DSP not only handles the processing of environmental sounds for gamers, but it's also integral to home audio production and effects processing that used to cost thousands of dollars in outboard equipment.



How To Pick the **BEST** **SOUNDCARD**

Advice that's music to your ears



There's a popular adage in the soundcard industry: If you show an audience a movie using a busted speaker running in mono, and then you show the same audience the exact same movie but with state-of-the-art speakers and in surround sound, they're bound to say the second movie *looked* better. The parable highlights the general perception of PC audio—it's often an afterthought to concerns about megahertz, pixels, and gigabytes.

But PC audio has come a long way since its days of scratchy hiss. Today's PCs sing in full surround sound and can play full 24-bit audio, producing realistic audio that seems to be emanating from all sides.

The first soundcards, most notably the original Creative Labs Sound Blaster, fit into the ISA slot. Today's soundcards are all PCI-based. When choosing a soundcard, you'll first have to decide how many channels you want. Several different multichannel outputs are supported today:

- **Two-channel:** Common stereo output from two speakers arranged in front of you, with one on each side of your monitor.
- **Four-channel:** PCs first adapted to "surround sound" by adding two speakers positioned to the left and right behind a user.
- **Five-channel:** To help fill the gaps, a center channel gets positioned directly between the left and right front speakers. In most DVD movies, dialog is played through the center channel.
- **Six-channel:** A sixth speaker positioned directly behind the listener's head helps fill out the rear audio.
- **Seven-channel:** Although there's little speaker support for it, the 7.1 configuration adds two speakers behind you for even higher precision in distinguishing rear audio cues.

Of the choices here, two-, four-, and five-channel are the most common. You'll easily be able to find speakers of these configurations. You'll see a ".1" behind the channels, as in 2.1 or 5.1. The .1 refers to a separate subwoofer in the speaker set. If you have a 2.1 set of speakers and you're worried about buying a soundcard with 7.1 support, don't sweat it. All consumer soundcards are capable of running with fewer than the maximum number of speakers. A 5.1 soundcard,

for example, will support 4.1 and 2.1. Soundcards cannot, however, run more than their maximum, so an older Sound Blaster Live! 4.1 soundcard will not support 5.1 audio.

Although multichannel soundcards are common, the majority of PC users run 2 or 2.1 speakers, or use headphones. Because of that, most soundcard vendors spend an inordinate amount of time trying to develop filtering algorithms that will fool you into believing that the audio from just two speakers is coming from behind you. It's an inexact science and the faux surround sound will not be equally satisfying to everyone. So we don't recommend basing a soundcard purchase on "virtual" surround sound.

The most effective technique for most people is nothing less than full 4.1, 5.1, or better, with speakers positioned behind their heads.

DIRECTSOUND, DIRECTSOUND3D, AND THE API WARS

It's difficult to discuss soundcards without dredging up the past. In the beginning, DOS-based video games, such as the original *Doom*, required that game developers write drivers for each video-card. On the other hand, Microsoft's API DirectSound and DirectSound3D let developers write to a common API (application programming interface) and not worry about the different soundcards.

But soundcard vendors, eager to differentiate themselves from each other, continued to develop their own APIs and features. Aureal's A3D was one of the strongest rebel APIs and garnered a fair amount of support from gaming developers, while Creative Labs pushed its own EAX API, which worked in conjunction with DirectX.

In the end, Creative's simpler API won out. Today, DirectSound3D and Creative's EAX are the prevailing APIs for games. EAX has also vastly improved with more subtle controls that affect how something sounds going through an object or reflecting off an object. As long as the soundcard you buy supports

Creative Labs' Audigy 2 is the prince of consumer soundcard families, offering 24-bit audio, a popular API, and niceties such as built-in FireWire.

DirectSound3D and some level of EAX, you're in good shape.

WHAT ABOUT ONBOARD AUDIO?

Just as soundcards have evolved, so has the audio on motherboards. Years ago, motherboard makers simply bought audio chips, such as a Sound Blaster, to embed on their boards. Onboard audio offered few frills then, but today onboard audio provides an amazing amount of functionality such as multichannel, coax, and optical digital links for truly finicky audiophiles, and even the ability to sense whether a microphone is plugged into a speaker jack. The overwhelming majority of today's onboard audio, however, relies on the CPU and drivers to do most of the heavy lifting. We remain suspicious of onboard audio, not so much because of the hardware, but because on many motherboards that we've reviewed, the audio software has been poorly implemented.

Among the most popular onboard vendors are Analog Devices, C-Media, VIA, RealTek, and nVidia. nVidia's nForce2 MCP-T audio solution is fairly unique in the audio space. Unlike the other onboard competitors, the nForce2 MCP-T is an audio "accelerator," and just like a graphics accelerator, it offloads processing of audio from the CPU. The nForce2 is also unique because it can encode audio in real-time to Dolby Digital. Hook any of the other audio solutions to a home entertainment system's Dolby Digital decoder, and all you'll get is DVD audio or stereo for games. Because the nForce2 MCP-T uses technology developed for the Xbox, it can output games in multichannel to a decoder.

Although onboard audio is clearly becoming increasingly sophisticated, we

still prefer the feature orgy associated with add-in cards. The Audigy 2, for example, does 24-bit audio, offers a multitude of I/O options (including a FireWire port) and is unique in its ability to play DVD Audio discs (in the event you happen to have one of those lying around).

THE 24-BIT QUESTION

Creative Lab's original Audigy helped take PC audio to the next level. Offering limited 24-bit audio support, the Audigy sounded head and shoulders better than the Sound Blaster Live! and the majority of other consumer PC soundcards. As its name implies, 24-bit audio simply packs in more audio information than 16-bit audio. If you imagine a sound file as a gentle curve, 16-bit is a jagged stair-step approximation of that curve. By increasing it to 24-bit, the jaggedness is reduced significantly and the sound is smoother and richer. Creative has been the sole retailer of consumer-level 24-bit audio cards for the last few years (as opposed to brawny, but expensive professional audio soundcards) but the competition is heating up. AudioTrak and M-Audio are among several vendors now offering affordable, multichannel 24-bit products. One limiting factor of the higher resolution is the lack of source material. Since the majority of PC audio is 16-bit (audio CDs are 16-bit as well), the benefit of 24-bit isn't as noticeable. The higher resolution, however, can benefit even the average game or MP3 file. Because 24-bit soundcards generally use higher-quality digital audio converters and codecs, 16-bit audio source material can sound improved over the garden variety 16-bit soundcard. Our endorsement of the Audigy 2 for consumer use stands.

top picks

AudioTrak Prodigy 7.1

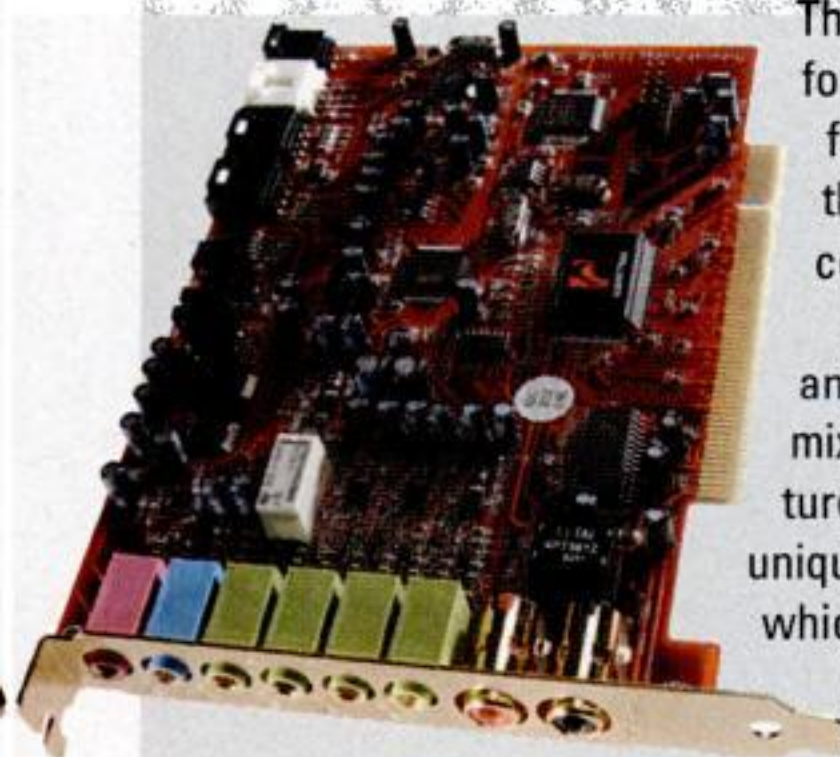
Like M-Audio's card, the Prodigy boasts 24/192kHz output, uses VIA's Envy24HT chip to handle I/O chores, and has Creative's Audigy 2 in its cross hairs. And just like the M-Audio card, the Prodigy relies on the powerful CPU inside your PC for most of its heavy audio-related number crunching.

In the battle for gaming frame rates in a 3.06GHz P4 B system, we saw the Prodigy trail the Audigy 2 by 4.6 percent in *Comanche* and 2 percent in *Quake III Arena*. In *3DMark2003*, the Prodigy lagged behind the Audigy 2 by about 8.5 percent.

These aren't ringing endorsements for host-based audio, but these performance losses wouldn't threaten the fun of anyone owning a kick-ass computer.

Compared with the Revolution, and its sparse control panel and mixer, the Prodigy is much more feature rich. The Prodigy also boasts a unique feature called DirectWIRE, which lets you redirect an audio channel from a DVD movie or protected WMA file, so you can record it to your hard drive.

In subjective listening tests with 24-bit/96kHz samples (the highest-quality audio most of us will ever encounter), we found the Prodigy 7.1 to sound just about the same as the Audigy 2, and just a hair worse than the Revolution 7.1.



top picks

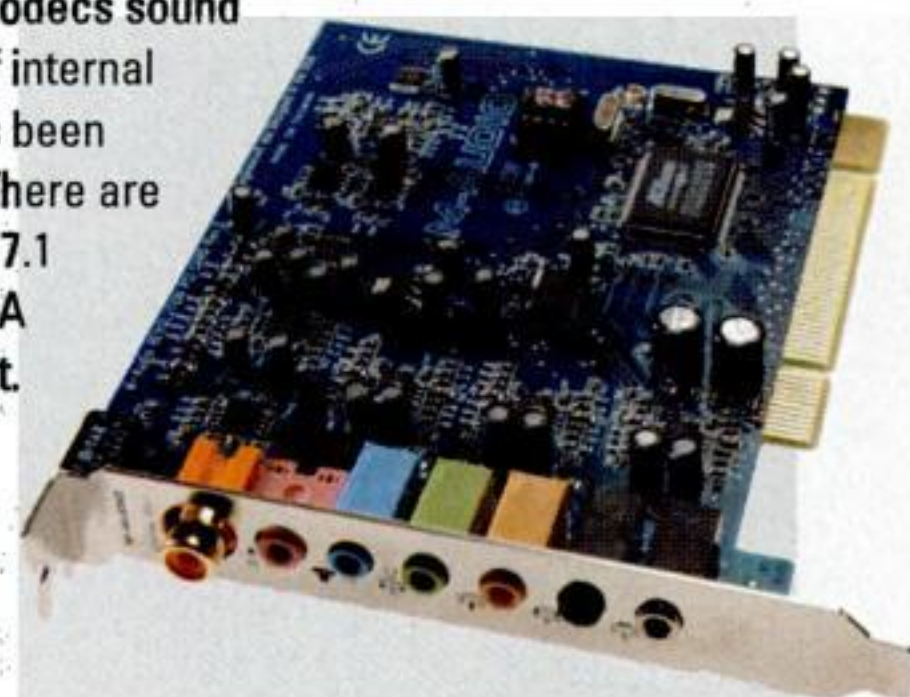
M-Audio Revolution 7.1

As CPU speeds have climbed to 3GHz and beyond, there's been a move afoot to throw more processing chores in the direction of under-taxed CPUs. Thus we have M-Audio's Revolution 7.1, a sweet-sounding, 24-bit soundcard designed for host-based processing.

The Revolution in many ways acts as a simple conduit to get audio from your games and applications to your audio-out jacks. Make no mistake, its 24-bit converters and codecs sound *huge*, but the card itself is bereft of internal audio connectors and looks like it's been stripped down and left on blocks. There are four analog-out ports (that support 7.1 analog speakers), as well as an RCA SPDIF out, a line-in, and a mic input. But that's pretty much it.

The Revolution also supports recording at 24-bit/96kHz with ASIO drivers—something the Audigy 2 will do only in the pricey Audigy 2 Platinum EX bundle. During subjective listening tests of games and music, some of us thought the Revolution 7.1 offered better audio rendering than the Audigy 2, while others called a tie, and still others stuck by Creative's mainstay.

On one hand, we have the first soundcard to sound as good as—or possibly better than—the Audigy 2. But all this comes with a frame rate penalty in games. Are you ready to trade 67fps for 52fps? Maybe, maybe not.



Creative Labs Audigy 2 Platinum

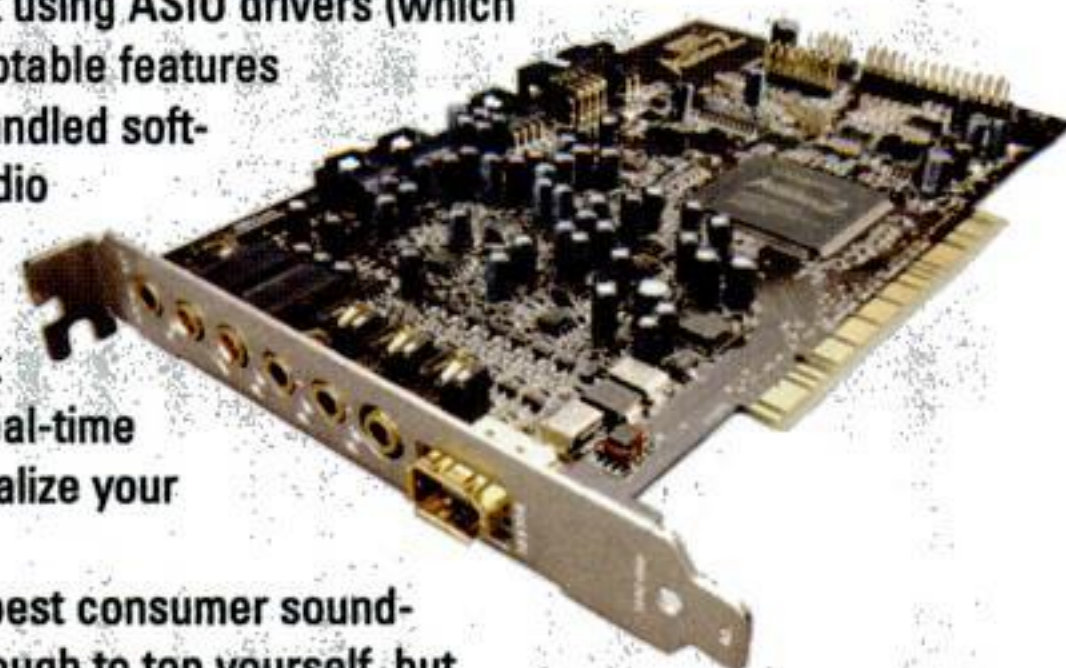
Already an Eagle Scout, the Audigy 2 adds several new merit badges to its chest: support for DVD-Audio, Dolby Digital EX, and 24-bit recording.

DVD-Audio is a format for a new breed of *music* discs—it provides high-res 24-bit/192kHz sound for stereo output, and 24-bit/96kHz for surround-sound output (that's right: 5.1 sound for regular music!). Having heard it ourselves, we can tell you that the improved fidelity of DVD-Audio makes today's 16-bit/44.1kHz audio CDs sound like bad MP3s.

Dolby Digital EX is your ticket to 6.1 surround sound, which adds a rear center-channel speaker to the existing 5.1 mix. Just as the front center-channel in a 5.1 system fills gaps in your soundscape, a sixth satellite directly behind your head helps audio dance around you in stark realism.

Creative has finally added 24-bit recording to the Audigy series, but you can't record in 24-bit using ASIO drivers (which reduce latency). Other notable features include less-annoying bundled software, an easy-to-use audio clean-up tool, improved CMSS algorithms for listening to stereo output on 5.1 speakers, and a real-time normalizing mode to equalize your MP3s.

When you make the best consumer soundcard on the market, it's tough to top yourself, but Creative Labs has succeeded with Audigy Part Deux.



HARD DRIVE

Logic board: Once upon a time, drives were pretty dumb and needed to be plugged into controller cards (via a PC slot) in order to work. These days, the controller is built right into the PCB beneath the drive, along with the drive cache, and lots of shiny things.

Voice coil/voice coil magnet: Hidden beneath this curved piece of metal is an extremely strong rare earth magnet. If you were to look closely underneath the metal shield, you'd just barely see the copper wire coiled beneath. When current is passed through the wire, the resulting electromagnetic field pushes or pulls the drive head assembly across the platters. The drive head assembly can sweep across the platter hundreds of times a second; each sweep causes a faint click that is the sound of a hard drive earning its keep.



IDE cable connector



LIVE

Read/write head assembly: Like the old cassette recorders of yore, there are two separate heads in a hard drive head assembly for reading and writing data. We're pointing out the "assembly" here because the actual read/write heads could be hidden behind the leg of a gnat.

Most modern hard drives employ GMR heads, which, oddly enough, is an acronym for "giant magnetoresistive" heads. Nobody was trying to be funny or ironic; the name comes from the "giant magnetoresistive effect," a sly technique discovered in the 1980s that allows weaker magnetic fields from the disk media to be picked up by the read/write heads. The result is more data packed into less space.

Disk media: Modern drives have several platters stacked one on top of the other like a stack of pancakes. Each platter is two-sided, and both sides are used for data storage. On the surface of each platter is an extremely thin layer of magnetic particles. Using a very delicate electromagnetic write head, these particles are organized and reorganized into neat groups that represent either 1s or 0s. The read head then reads these "bits" and translates them back into digital data.

Spindle motor: This is the motor that spins the platters of a hard drive. Each platter is supported by ball bearings around the circumference of the spindle motor to prevent excess wobbling. Newer hard drives use fluid dynamic bearings, however, which use a thick oil to stabilize the platters without the whirring racket of ball bearings.

Flex circuit: This thin ribbon provides power to the head assembly. It also has a tiny pre-amp built into it that amplifies the wee signals picked up from the platters.

Master/slave jumpers

Power connector

How To Pick the **BEST** **HARD DRIVE**

Bigger, faster, and smarter—meet the new crop of hard drives

Your CPU and videocard are glamorous components, with impressive-sounding descriptors like “gigahertz,” and faster iterations popping up every few months. But the hard drive is the heart of your PC. It’s the basket where your PC puts all the goods—your OS, your applications, and, of course, all your valuable data.

Not much more than a decade ago hard disk storage was expensive and fairly limited in capacity. But today, it’s almost an afterthought. A high-performance drive from a major manufacturer like Western Digital will cost you less than a buck per gigabyte. So it’s tempting to just grab the biggest one you can find and assume you’re set for a year or so.

Not so fast, big guy.

Your hard drive is a mechanical device, and it won’t ever challenge solid-state components like your CPU and RAM in the speed category. But it does do its job—keeping your CPU and RAM fed with the data they hunger for—reliably and cheaply. So given that we’re stuck with the technology for the time being, we may as well minimize the drag on our system’s performance by intelligently selecting the right hard drive.

A FEW NANOSECONDS IN THE LIFE OF A HARD DRIVE

If you want to understand what makes one hard drive faster than another, well, wouldn’t you know, you need to understand a bit about how they work. It’s a lot more interesting than you might imagine.

Suppose a program is looking for a file. Your operating system

and hard drive work together (mediated by a disk controller built into the drive) to find out where the file is physically situated on the disk. Disk addressing is done in terms of tracks and sectors (which can be thought of as rings and points on the rings). If the data has already been read and stored into a small amount of built-in memory called the “cache,” then the data is served up directly from the chip. This would be the case, for example, if you reopened a document that you just closed. If the data isn’t there, then the drive needs to retrieve the data by moving the read and write heads to the right disk location.

The read and write heads (they are separate) are mounted at the very tip of the arm assembly. The assembly is similar to the arm and stylus of a classic record player, except that instead of being driven by a motor and belt, the arm is moved by a very strong and precise magnet capable of rapidly twitching the arm

to and fro. The read and write heads float above the surface of the drive platters, which store digital information in a thin layer of magnetic particles (like cassette tapes).

Once the read head arrives at the correct track, the drive needs to wait for the platter to spin to the correct sector before reading. Once the data is picked up, it is passed to the cache, and then on to the rest of your PC for processing.

SPEED METRICS FOR POWER USERS

Now that you know some of the essentials of how a hard drive works, let’s look at the attributes that determine what kind of performance you’ll get from your



Cross-licensing accounts for the similarities in hard drives from different manufacturers.

But drives do exhibit subtle differences, like the ramp-style head parking mechanism in this Hitachi drive.

drive. Again, it comes down to the efficiency of physically moving parts.

Rotational speed is the speed at which the spindle motor spins your drive platters. The faster the rotational speed, the less you'll have to deal with the effects of rotational latency, which is the time it takes for a disc to spin the right sectors past your drive's read or write head. Think about it like this: If a bus runs through a city loop at 10 miles per hour versus one that runs at 20 mph, and you just missed both of them, the 20mph bus will come back your way sooner. Faster rotational speeds also help with transfer rates, by way of passing more bits under the head with every rotation. Don't settle for a desktop drive that runs at less than 7200rpm.

Another number getting a lot of attention in the past few years is the cache size. Western Digital turned over the desktop drive industry with 8MB caches (compared with the then typical 2MB) and other vendors soon followed



"Are you sure we can't fit in one more?" Jeff, Betty, and Bernard check out the first IBM hard drive, boasting 50 platters, each 24 inches across.

suit. A larger cache has more room for stored data, thus increasing cache "hits," which are

successful retrievals from the fast cache instead of the relatively pokey drive platters. A 2MB cache

YOUR GUIDE TO SERIAL ATA

Why the PC industry is rushing away from parallel ATA

Take a look at a machine equipped with Serial ATA, and its most striking feature will be the skinny data cables. While skinny cables have a positive impact on a case's internal airflow, this isn't the main reason why the PC industry is dropping parallel ATA (and its flat, wide cables) for SATA. The main reason is that the current parallel interface is facing a performance wall.

Parallel ATA cables send data along multiple wires. Each piece of data must travel along the length of the familiar ribbon cable, and arrive at the same time in order to maintain data integrity. In order to get more speed from this scheme, the only option is to push the data to higher frequencies or make the data path wider. That's where the problems lie. Making the data path wider is impractical, as there are already 80 conductors in the ribbon. And increasing speed adds to the likelihood of data corruption.

Because serial interfaces don't have to deal with coordinating multiple lanes of data, we're able to push them to much higher speeds. SATA is currently rated for 150MB/s, slightly higher than the 133MB/s offered by the fastest parallel ATA spec (which still hasn't been

widely adopted). SATA will eventually double to 300MB/s in 2004, and then again to 600MB/s by 2007.

The first SATA implementations on motherboards were kludgy: Serial ATA chips were piped through the PCI bus. This limited the 150MB/s potential of SATA to PCI's 133MB/s throughput, and required the loading of drivers just to recognize the chip. But current-generation SATA-equipped motherboards should be plug-and-play. In Intel's new ICH5 southbridge chip, for example, SATA is native. Plug a SATA hard drive into an 875P motherboard, and you can load WinXP without needing to install any drivers.

Because of their bandwidth needs, hard drives were the first SATA candidates, but next year we'll likely see the first optical drives with SATA interfaces. Because of the glut of parallel devices, it'll probably take two to three years for the PC industry to drop parallel ATA entirely.

Although current hard drive data rates fall far short of the maximum throughput of even parallel ATA specs, companies are laying the foundation for the future. You don't, after all, wait for the traffic jam before you try to build the roads (unless you run the state of California).



is acceptable, but we've observed dramatic improvements in performance with hard drives that utilize the brawnier 8MB cache.

The most misunderstood performance stat is the interface speed. Interface speeds like ATA66, ATA100, and ATA133 are, for the most part, much faster than what your desktop drive is able to continuously transfer, and rarely, if ever, constrict your data flow. These standards (representing megabytes per second) are more than capable of handling the 60MB per second or so of traffic that a drive can continuously deliver. For proof, we tested an identical ATA133 capable drive with an ATA100 and ATA133 controller, and came out with identical scores. Even the new SATA150 interface had virtually no performance advantage over an identical drive with an ATA100 interface. You don't need an ATA133 drive if you've already got an ATA100 drive. In fact, we question whether buying an ATA133 is wise at all—you'd be better off trading up to a Serial ATA drive (but make sure you get a motherboard or controller card that supports it).

Note that more than one drive on a single channel *will* overload an ATA66, and will likely strain even an ATA100 interface at times. The lesson: Always keep your hard drives on separate channels!

Seek time describes how quickly a drive can move from one place on the drive platter to another. It can be expressed as average seek time (meaning how long it takes to go from one random position to another), and full stroke (which measures the travel time between the outermost and innermost tracks). Most current drives post average seek times between 8 and 10ms (milliseconds). These numbers are useful, but don't go overboard. For example, some SCSI drives have average seek times as low as 5ms; you'll notice a difference between this and your bread-and-butter 9.5ms desktop drive. Less urgent is the difference between a drive with 8.5ms and a 10ms average seek time—and the lower rated one may be much more expensive. Stick with a high-rpm drive, and use common sense. Lower average seek times are better, but you won't want to pay through the nose for a slightly lower figure. If performance is that crucial, consider a RAID setup.

DESKTOP VS. SERVER DRIVES

Hard drives are designed for specific tasks that generally fall into two categories: server and desktop duties. The high-rpm SCSI drives can handle many simultaneous tasks—essential for servers that get requests from many different users at the same time. Desktop IDE drives are designed to work most efficiently when data is requested in relatively bulky chunks, although many contemporary drives are handling server-type requests with greater efficiency. Server drives are much more expensive, however. Overall, you'd be better served by a Serial ATA or IDE RAID setup.

top picks

Western Digital Raptor 10K

The new 360GD Raptor is the first ATA drive to offer a five-digit rotational speed (SCSI drives have offered 15,000rpm for quite a few years). Faster platters make random access times go down, while transfer rates go up. The Raptor is a Serial ATA drive (Western Digital's first), and it's intended for light server duty (despite the fact that Serial ATA will become the new desktop standard). But the real story here is the drive's mastery of data handling and throughput.

HD Tach's sequential read test (which calculates the average data reading rate across a whole platter) coughed up a score of 55.1MB/s. Writing across an entire platter was equally impressive at 33.5MB/s.

In our custom-configured *IOMeter* desktop test, we thrash hard drives with so many random input/output operations, they usually puke and beg for mercy. The Raptor, however, finished with a score that was roughly 30 percent faster than the former record-holder.

There is a downside to putting this server drive in your desktop rig. Its capacity is limited to 36GB. Server storage usually consists of several smaller drives conjoined in RAID, so smaller drives are preferred. Still, we don't mind the puny capacity.

Go for the Raptor if the capacity doesn't bug you, you need break-neck speed, or have a reason to upgrade to SATA. This is the swiftest non-SCSI drive around. We just can't wait until WD comes up with a desktop-oriented version.



Western Digital 2500JB

The new Western Digital 2500JB doesn't spin at 10,000rpm, but the 7200rpm drive does offer desktop users a compelling argument in its favor. Capacity reaches 250GB across three incredibly dense platters, and an 8MB cache provides a boost for regular-old home PCs.

So what makes the latest 8MB cache Western Digital "JB" drive worthy of your attention? It really comes down to speedy sequential transfer read speeds and a cache optimized for desktop work. Read speed is important for everyday work activity, and sure enough, the 2500JB beat Hitachi's top-performing 180GXP drive in *SYSmark2002*, a benchmark suite based on real-world apps. The Western Digital won by just two points, but its *SYSmark2002* showing only backed up the drive's even better showing in *HD Tach's* read test.

If you're doing video-capture or file serving, the Hitachi 180GXP, with its higher areal density would be the better purchase. But if you're sticking to normal everyday desktop tasks and need a huge primary drive, then this 250GB drivezilla is a wise choice.



How To Pick the **BEST** MONITOR

CRT or LCD—what's the diff, and which one is best?

Very few power users consider the CRT monitor to be a glamour component. After all, cathode ray tube displays are based on essentially the same technology found in common TV sets—that old-school technology was invented way, way back in the 1920s (the date of television's official birth is open to debate, but that's another story altogether).

Yes, CRTs are completely “yestertech” compared with videocards and optical drives, which seem to be reinvented every six months, but they cannot, must not, be underestimated. Think about it. A good CRT can potentially be a system's most expensive component. Even more importantly, CRT life cycles are relatively long, so the monitor you buy this year will likely be the same one you're using in 2006. Think you'll be running the same CPU, hard drives, and videocard in 2006? For the sake of your games and applications, we certainly hope not. But you'll probably be running the same CRT, so you best take your CRT purchasing decision seriously.

CRTs offer a few key benefits over flat-panel LCDs: (1) In most cases, they offer more square inches of screen real estate for every dollar spent. (2) They can display quick-moving video and 3D gaming content without any hint of streaking and trailing whatsoever. (3) They can display every single color a videocard can produce—no excuses, no ifs, ands, or buts. (4) They can display multiple resolutions, from 640x480 to 1600x1200 and beyond. (LCDs have only one “native” resolution, and this can lead to problems.)

But CRTs are not without their foibles: (1) Compared with LCDs, they're heavy as all get-out, emit more heat, and consume much more desk space. (2) Their screen image is more prone to geometric distortion. (3) Bad CRTs can

exhibit a fuzzy picture.

Maximum PC prefers CRTs over LCDs for gaming and image-editing work. A flat-panel LCD is easier to transport to LAN parties, but we are loath to give up native support for multiple game resolutions.

As for image editing, very few LCDs can accurately display the full range of color and grayscale gradation in continuous-tone images. That said, if you're only going to be typing and web surfing on your new computer, we think that high-quality, high-resolution LCDs are hard to beat.

OK, so you've weighed the strengths and weaknesses, and you've decided a good CRT is the best monitor for you. The next step is to choose between shadow mask and aperture grille technology.

POKING HOLES

Shadow mask and aperture grille are two different technologies that perform the same function: By using either a perforated sheet of metal (a “mask,” if you will), or a series of narrow, vertical metal strips (a grille, by any other name), shadow masks and aperture grilles help confine a CRT's electron beam, ensuring that the beam triggers only the red, green, or blue phosphor dots that need to be illuminated (these dots congregate in triangular arrangements called triads). Once a phosphor dot is triggered, it glows with color, and, voila, you have a screen image. This is a gross simplification, of course, and we wish we had



The Cornerstone P1750 is a good, honest, inexpensive 21-incher. It doesn't offer the exacting visual quality of the Sony F520, but it's a very respectable \$600 monitor.

enough space to explain how CRTs *actually* work. But for the purpose of this article, we'll simply explain the pluses and minuses of each “masking” approach.

➤ **Shadow Mask:** Shadow mask CRTs tend to be less expensive than aperture grilles. They also lack the faint, horizontal lines that span the screens of aperture grille CRTs. On the downside, shadow mask CRTs usually offer dimmer, less vibrant screens than aperture grilles, and they typically don't match their cousins' fine detail reproduction.

➤ **Aperture Grille:** Every CRT monitor company's highest-quality, pro-level offering is an aperture grille display—does that give you an idea of which technology is superior? The key thing to remember is that grilles allow more electrons (and thus light) to pass

through to the phosphor layer, and this fosters a brighter, more brilliant screen image. The best aperture grille CRTs also boast the finest pitches.

SPEC TECH

Buying a monitor based on its advertised specs is always a dubious proposition. Still, the specs you see on CRT cartons do mean something, so let's get to the bottom of them:

► **Size/viewing area:** You've probably already figured out that a "19-inch" monitor doesn't offer 19 diagonal inches of screen real estate—it actually comes in at around 18 inches. Then you have the problem of 21- and 22-inch monitors essentially falling into the same size category. Sony specs its best 21-inch CRT at 19.8 viewable inches, while NEC specs its primo-grande 22-inch CRT as having 20.0 viewable inches. NEC's viewable diagonal is just 0.2 inches longer than Sony's, but

box advertising would suggest a full inch of difference. Buyer beware.

Our overall advice is to pay closest attention to actual visible viewing area specs, and always purchase the largest, most brilliant CRT that your desk (and budget) can support. Actual visual quality is very important, yes, but we'd still rather have a 21-inch CRT with "good" visual quality over a 17-inch CRT with "category-leading" visual quality. There's just no replacement for screen real estate.

► **Dot and grille pitch:** A CRT's sharpness is directly related to its dot or grille pitch (dot pitch applies to shadow mask displays; grille pitch to aperture grille displays). In simple terms, a monitor's pitch describes the distance between one of its phosphor dots and the next closest dot of exactly the same color. The CRT industry doesn't use a standard way to measure this distance, but, in general, regardless of which type of

CRT you buy, you'll want to go with the lowest pitch spec possible. For example, Sony's 0.22mm grille pitch CRT is preferred to its 0.24mm pitch CRT. The smaller the pitch, the finer your screen pixels will be, and thus the sharper your overall image.

With some aperture grille monitors, you'll see a grille pitch spec that describes a range; for example, "0.25mm-0.27mm." This means that the pixels in the center of the display are sharper than the pixels on the display's perimeter—they ramp from a 0.25mm pitch to a 0.27mm pitch. Is the gradation noticeable? We don't think so.

However, you should be concerned with shadow mask specs that describe a "horizontal dot pitch" of a super-low figure like 0.22mm. Shadow mask vendors have

traditionally quoted diagonal pitch specs, despite the fact that diagonal pitch numbers never look as attractive on a spec sheet. To wit, a CRT's horizontal dot pitch equals 0.866 times its diagonal dot pitch. The upshot is that a 0.22mm horizontal dot pitch offers the same level of screen sharpness as a 0.25mm diagonal dot pitch.

► **Resolutions/refresh rates:** Every CRT displays a matrix of dots to describe whatever image is being presented on screen. This matrix is called its resolution. The lowest standard resolution you'll ever see supported is 640x480 (480 lines of 640 individual dots), but the best consumer CRTs can display 2048x1536. The higher your resolution, the more visual information can be displayed on your screen. Do you really need a 2048x1536 display? Probably not, unless you're doing high-end graphic design. Still, high-resolution support is the hallmark of a good CRT.

A monitor's refresh rate is directly related to its resolution. In simple terms, the refresh rate describes how many times per second a CRT redraws its screen. But here's the catch: The higher the resolution setting, the more difficult it is to redraw the screen. Thus, as resolutions go up, refresh rates go down. This is true for all CRTs. The key is finding a CRT that can maintain high refresh rates (75Hz and above) at high resolutions.

We suggest that you avoid any CRT that can't maintain a refresh rate of at least 85Hz at 1600x1200. A refresh rate below 75Hz will give you eyestrain, and any rate above 85Hz could possibly lead to blurry pixels.

AIN'T LCDs GOOD FOR NOTHING?

Flat-panel LCDs are seemingly taking over the PC market. But are they really the best choice? First, let's consider their pluses: (1) They're light and easy to carry, they don't take up much physical desk space, and they don't consume much electricity or emit much heat. (2) Because LCD pixels are arranged on a fixed, physical grid, geometric distortion is an impossibility. (3) They offer a



Apple's LCDs do in fact work with PCs. And their visual quality is absolutely kick-ass. Just be aware that all of Apple's display controls are accessed via a MacOS menu, so if you run the 23-inch, 1920x1200 Apple Cinema Display on your PC, you will not be able to tweak its pixel properties!

sharp, crystal-clear image when running in their native resolution.

Sounds like one big pixel-loving party, right? Well, LCDs also have their problems: (1) They still cost more than CRTs, all screen sizes being equal. (2) Some can't display fast-moving video and games without streaking (for example, a quick-moving hockey puck might look like a comet with a tail). (3) They don't have the color accuracy of CRTs, thus they're not ideal for image-editing work. (4) When running in their non-native resolution, they must "interpolate" pixels, and this leads to horribly degraded visual quality.

OK, so let's say you're copasetic with the inherent weaknesses of LCDs. It's now time to deconstruct their specs.

► **Viewing area:** When an LCD is marketed as a 17-inch display, you really do get 17 diagonal inches of screen real estate. More is better—buy as much screen as you can possibly afford.

► **Pixel pitch:** A smaller pitch is better, and will provide a sharper screen image. And unlike CRTs, all LCD pixel pitches are measured in a consistent manner. So when comparing flat-panels, you might as well opt for those with the smallest pitch specs.

► **Resolution:** Because your LCD will essentially be fixed at a single resolution, you better make sure it's the right resolution for your screen size. For 17- and 18-inch LCDs, we prefer 1280x1024. For larger monitors, 1600x1200 is preferred. (Note: LCDs don't have refresh rates, per se, so don't be worried if you see that an LCD is preset to run at a low 60Hz or 75Hz.)

► **Pixel response:** This spec, expressed in milliseconds (ms), refers to the speed at which the LCD's pixels can change color. Speed is important because if the pixels can't switch quickly enough, fast-moving screen content will exhibit streaking. Generally speaking, any LCD with a pixel response spec of 25ms or faster should be problem-free. That said, just because an LCD is advertised to hit 25ms doesn't mean it can switch at 25ms, so buyer beware. It always pays to run some content on the LCD before purchasing. But for what it's worth, even today's lamest LCDs can switch pretty damn quickly, and we haven't seen horrible streaking problems in a while, even in budget models.

► **Brightness:** This spec is expressed in candelas per square foot or meter (a candela is the total amount of light emitted by a single, standard candle). For example, a particular Sharp LCD can display 200cd/m²—200 candles per square meter. Higher brightness specs are preferred.

And with that, it's time to name our favorite CRT and LCD displays!

top picks

Sony F520

This is it, folks, the best CRT monitor available today. The F520 boasts a perfectly flat screen surface that not only fosters a more natural viewing experience (it turns out that humans actually prefer seeing flat images on flat displays), but also helps reduce reflections from ambient light. The F520 also offers colorful brilliance, a 19.8-inch diagonal viewing area, and a 0.22mm grille pitch, which is the finest grille pitch in the known consumer universe.

The F520 can reach as high as 2048x1536, and at 1800x1440, it can hit 85Hz. Now, CAD-level resolutions are all fine and dandy for bragging rights, but even hardcore home enthusiasts can appreciate faster refresh rates (which can remove frame rate bottlenecks in 3D games), as well as the F520's improved geometric accuracy.

Unfortunately, the consumer public wants shorter-depth monitors with flatter screens, so flat-screen 21-inchers have always suffered heinous corner geometry. Until now. Through the magic of correction circuitry, Sony has managed to achieve near-perfect geometric accuracy in the corners of their top-of-the-line, flat-screen CRTs.

Kudos to Sony's R&D department for correcting a subtle though nonetheless significant flaw.

Sony's industry-leading grille pitch is what separates the F520 from all other competitors. Simply stated, the F520 offers the sharpest, most detailed picture of any monitor we've ever seen.



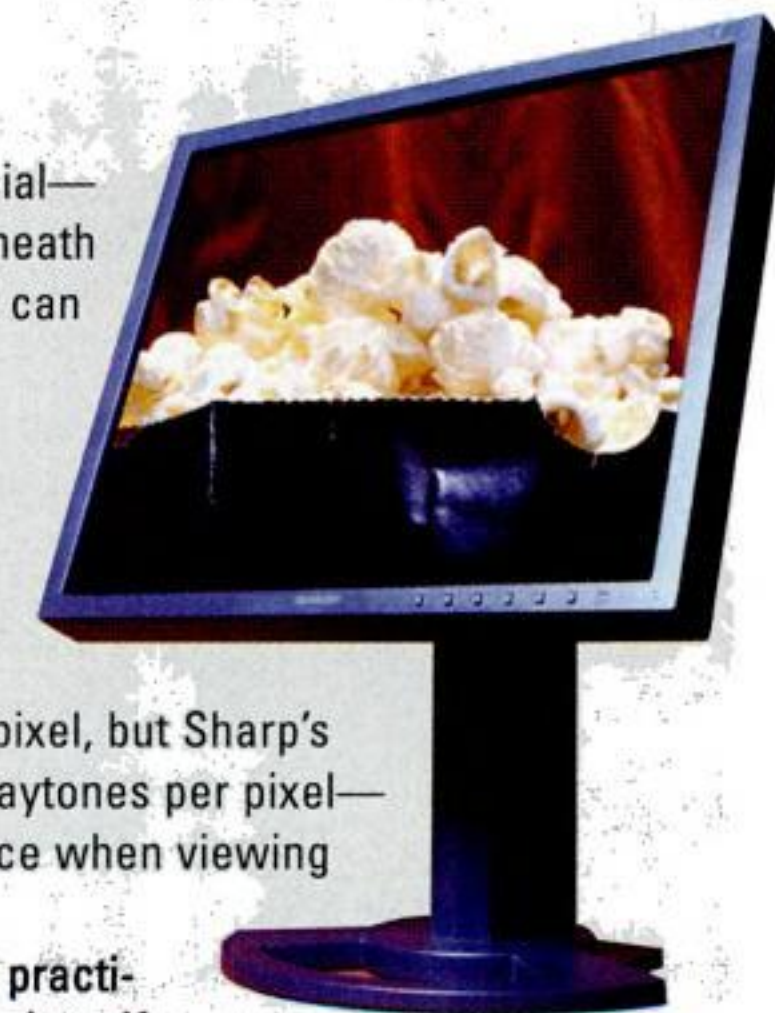
Sharp LL1820

This 18-inch Sharp doesn't look like anything special—but don't let the ugly-duckling act fool you. Underneath the mousy exterior are two new technologies that can measurably improve image quality: 10-bit gamma correction and Zero Voltage Black.

10-bit gamma correction increases the number of colors the monitor is able to resolve, and this in turn can produce much finer color gradations in photographic images. Traditional 8-bit gamma correction allows for 256 graytones per pixel, but Sharp's new 10-bit gamma correction allows for 1,024 graytones per pixel—and those extra color tones can make a difference when viewing high-detail pics.

Zero Voltage Black is an engineering trick that practically renders the annoying broken pixel effect obsolete. If you have a broken subpixel, applying voltage has no effect on the alignment of the liquid crystal material—light permanently shines through. The result is a persistent fleck of beaming bright light that mars an otherwise normal screen image (and, of course, most LCD displays ship with a few broken pixels; it's a manufacturing inevitability). Zero Voltage Black reverses the voltage model. The application of voltage opens the subpixel's window shade, while the absence of voltage closes the window shade. The upshot is that broken subpixels on Sharp's new displays are relatively unobtrusive.

It would be easy to knock the LL-T1820 because it's not a 20-incher, but that would be missing the point. Its technology is truly bleeding-edge, and has already found its way into larger Sharp displays.



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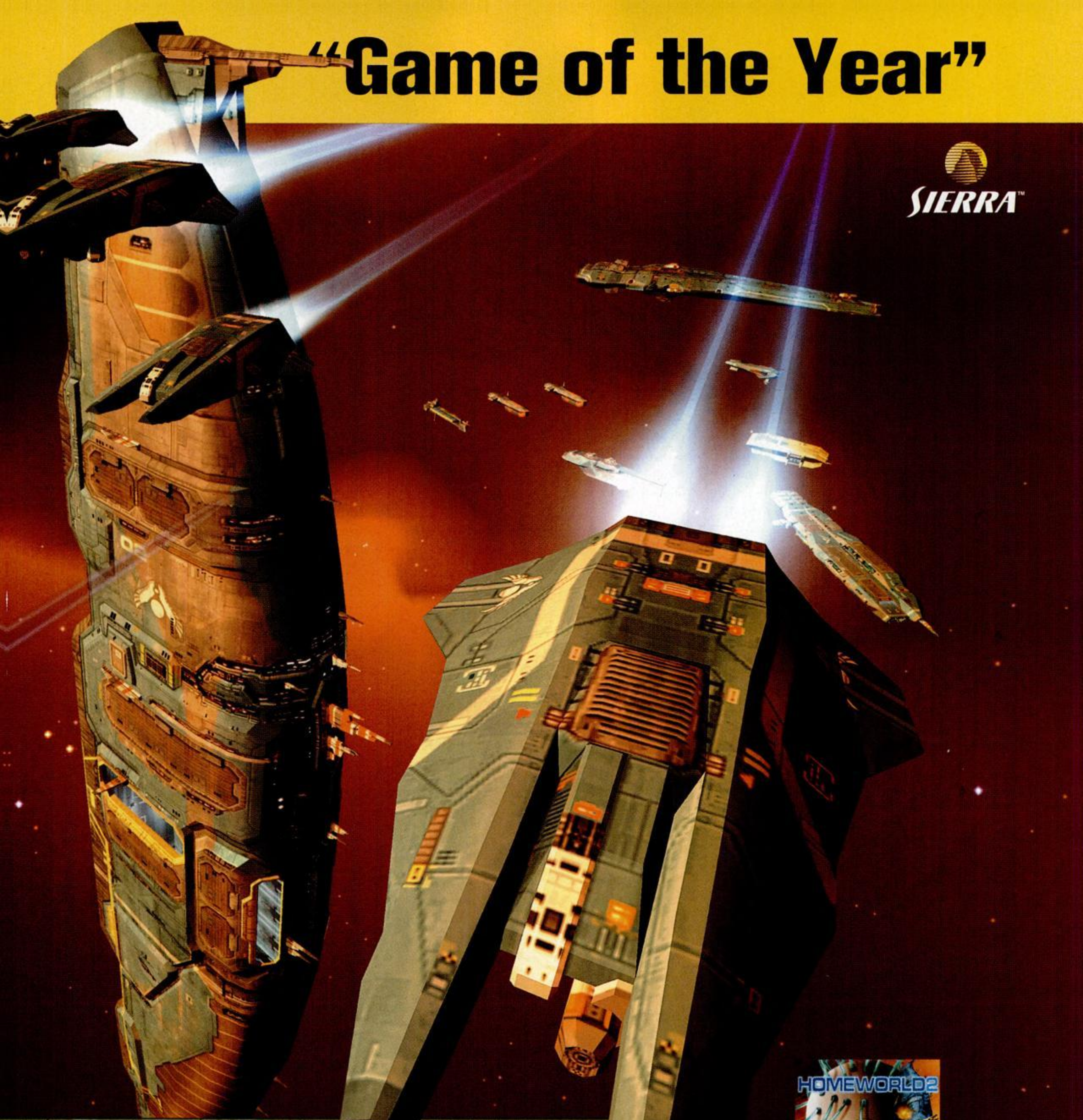


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How To Pick the **BEST** CD BURNER

Spinning the newest generation of CD burners

Even Luddites who once scoffed at the idea of owning a personal computer fell under the seductive spell of CD burning. At the same time CD burners were plunging in price, certain applications that could be used with them (read: *Napster*) were growing in popularity, reinforcing the PC's inextricability in all our lives.

Today, ultra-fast CD burners are so ubiquitous, they may as well be sold in blister-packs at the local drugstore. But make no mistake: "High speed" does not mean "high quality." It's worth it to pay a premium for a quality drive and brand-name media. Those extra dollars today will pay big dividends tomorrow.

Before we talk about the features you need in a CD burner, let's look at the basics of how a burner works.

THE EZ BAKE OVEN OF YOUR PC

Compact discs store data in a single, continuous track that begins at the inner ring of the disc. The data is stored digitally—that is, every bit of text, imagery, or sound is stored as a sequence of 1s and 0s. On a commercially pressed disc, these 1s and 0s are represented by pits (areas that have been microscopically indented) and lands (areas that have been left flat). The laser on your CD-ROM drive or CD player is reflected to an optical sensor when it hits a land, which results in a "1." When the laser hits a pit,

the light is reflected away from the sensor, resulting in a "0."

Home CD burners don't really create pits and lands like commercial CD presses do, but they function in the same manner. Instead of pressing an indentation into a disc's surface, a consumer drive "burns" a mark into a photosensitive dye on the disc that's protected by a transparent plastic layer. Wherever the disc is left untouched, the laser light is reflected and a "1" is registered. Wherever the disc has been burned, the laser light is absorbed and a "0" is registered. When you finish burning a disc, you can actually see the difference between the used and unused portions of a disc—the burned areas are slightly darker. (In its day, Yamaha's clever CRW-F1 allowed you to burn images and text in the unused portions of a disc by taking advantage of the difference in reflectivity of burned and unburned areas.) Rewriteable media works similarly, except that the photosensitive layer is replaced by a polymorphous layer. Like the T-1000 Terminator, this layer can change from one form to another and back again; from burned to unburned, in other words.

WHY MEDIA MATTERS

How a particular CD burner interacts with a particular type of media is called a "write strategy." Believe it or not, optical drive manufacturers tailor the strength of their laser to different brands and dye formulations on different kinds of media. This information is stored in the drive's firmware, a piece of rewriteable, non-volatile memory in your CD burner. When you pop in a disc, the CD burner reads information about the disc imprinted in a small area called the ATIP, and adjusts itself accordingly. Quality drive manufacturers like Plextor and Lite-On constantly update their firmware to accommodate different kinds of media and implement

new write strategies for them. No-name manufacturers are more apt to let this kind of thing slide.

This is your hint to buy quality, brand-name media. You'll find that manufacturers such as Verbatim and Memorex consistently deliver a more reliable product as a result of using higher-quality dyes that not only provide higher reflectivity, but longer-lasting discs as well.

BUFFER-UNDERRUN PROTECTION

Insist on a drive that offers some kind of buffer-underrun protection. (Actually, the point is somewhat moot as virtually every CD burner has it these days.) There are times when a PC can't feed data to the CD burner fast enough; this is known as buffer-underruns. If a drive is unequipped to protect against buffer-underruns it will stop running at the moment the buffer is depleted, resulting in an unreadable disc. Buffer-underrun protection enables a drive to pause while the buffer is replenished and then resume burning chores where it left off.

DIGITAL AUDIO EXTRACTION: GETTING EVERY LAST DROP

The "Red Book" CD Audio specification was designed for fault-tolerant playback, not flawless digital audio extraction (aka "ripping" music tracks from audio CDs). In order to understand why a good optical drive matters, it's important to understand how error-correction schemes work, and why digital audio extraction can be such a tough job.

The pits and lands that represent digital information on an audio CD are microscopic, so a scratch on the surface, even a tiny one, is bound to obliterate a few bits of data. The CD spec was designed to compensate for this inevitable wear and tear with a number of error-correcting schemes. The first, and relatively simplest, is called C1 correction. Data written to a CD is surrounded by a matrix of confirmation bits that are referenced when data is obscured. It works a lot like algebra: When you see the equation $9 + x = 10$, you know x has to represent the number 1, even though the middle digit is missing. By the same token, if 9 is the available audio data, and 10 is the confirmation bit, the error-correction scheme knows the missing audio data is 1.

C2 error correction is far more complex. With C2, one block of audio CD information is interleaved with information from many other blocks. This way, a surface scratch will affect only small parts of many blocks, instead of a large



Yamaha's cool image-burning CRW-F1 is no longer manufactured—Yamaha ditched its optical drive division—but that's what eBay is for.

top picks

Plextor PlexWriter Premium

The latest optical drive from Plextor is not only the 52x burner that Plextor said it *wouldn't* make, but it also includes such a cavalcade of features, it's unlikely another company will ever be able to match the drive's utility.

First, the basics: 2:41 (minutes:seconds) to write a full, 700MB CD. Seek times were the lowest in the business at 66ms and 114ms for random and full-stroke access, respectively. And digital audio extraction appears to have been approached with Plextor's characteristic perfectionism.

Now let's get to the "premium" aspects of the PlexWriter 52x package:

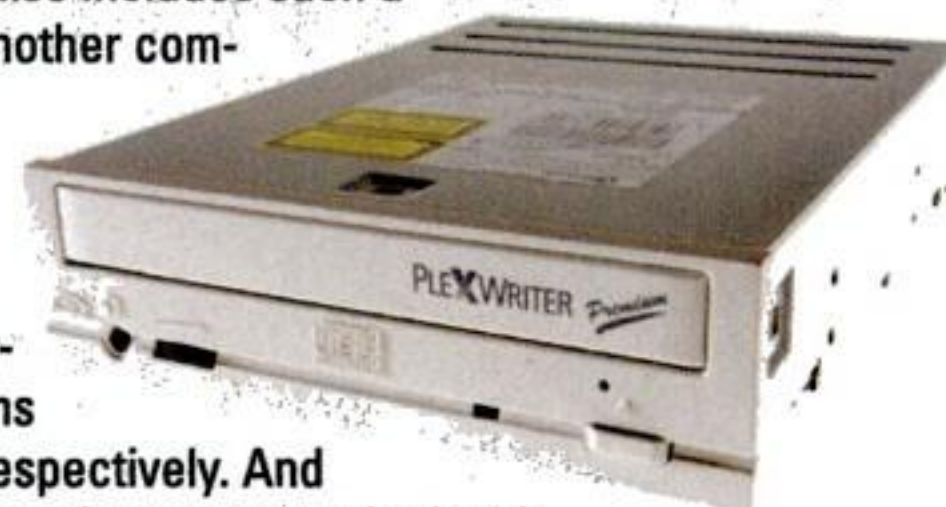
- By brazenly ignoring the "Orange Book" (data) and "Red Book" (audio) authoring standards for recordable CDs, the PlexWriter Premium can stuff a little less than a gig of data on a 700MB CD!

- Upon your request, the SecuRec feature password-protects discs written with the bundled *PlexTools Professional* software.

- VariRec allows you to subtly adjust the strength of your drive's laser to make discs more compatible with a CD player or CD-ROM drive.

- Silent Mode gives you the option of throttling down read and write speeds for quieter drive operation.

In this age of super-fast burning, a small decrease in CD burning time no longer warrants applause. But fusing fast operation, a quality build, and oodles of innovative features does deserve our accolades.



Lite-On may not be a household name, but in our tests, its drives consistently hit the top speeds for the bottom dollar.

HOW FAST IS FAST ENOUGH?

A 52x burner sounds sexier than a 40x, no doubt about it. But the difference in speed is minute—about 45 seconds at the most, and you'll only realize that advantage when writing to the full capacity of a 700MB disc. That's because the top burning speed of the drive is reached at only the outer extremities of a disc (where the track circumferences are longer and the data rate increases). If you've already got a 32x drive or above and are happy with its features, there's no compelling argument to upgrade to a faster drive. But then again, optical drive prices are so low these days, you might not have to pay much simply to have 52x burner bragging rights.

See page 79 for more information on CD burner specs.

Lite-On 52x

We never dreamed we'd be singing the praises of CD rewriting, but here we are: 32x rewriting speeds rock. For the first time, we wrote 647MB to a CD-RW in less than three minutes—2:57 (min:sec), to be exact. Granted, 32x CD-RW hardware isn't exactly new, but 32x media has taken its sweet time to arrive. Now that it has, we're impressed. We might actually stop wasting our 700MB CD-Rs just to transfer files to and fro.

Rewriting at 32x wasn't Lite-On's only surprise. The drive case shrunk down to a mere 6.75 inches long. That's almost an inch shorter than previous Lite-Ons, clearly a nod to the vast number of folks adopting low-profile or Shuttle cases.

The rest of Lite-On's benchmarks yielded neither surprises nor disappointments. We extracted 74-plus minutes of audio from a commercially pressed CD in a category-leading 2:20. We also burned a full data CD in 2:39, and observed just slightly less than a full 40x write transfer-speed average across the span of the entire disc.

Lite-On quickly built a name for itself making quality drives for suspiciously low prices. That tradition continues.



DVD BURNER

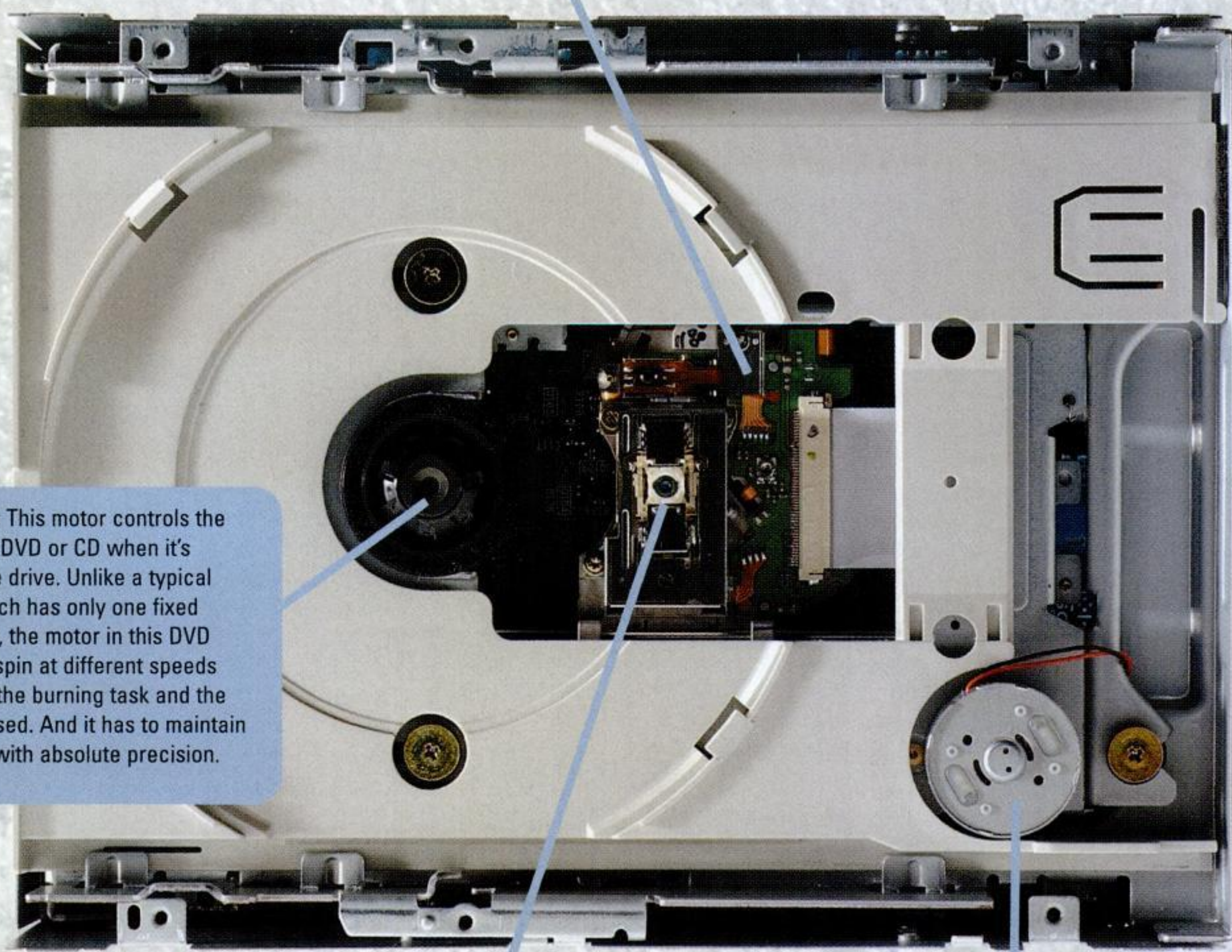
Interface PCB (underside of drive): This is the main PCB (printed circuit board) that contains the chips and connectors for interfacing the drive to the PC. It also contains special chips for adding all the control information necessary for creating the DVD structure on the disc.

Optics control PCB: This PCB accepts the signals from the interface PCB and translates them into the laser pulses needed to actually burn the disc, and to control the focusing and tracking of the laser.

Spindle motor: This motor controls the rotation of the DVD or CD when it's loaded into the drive. Unlike a typical hard drive which has only one fixed rotation speed, the motor in this DVD burner has to spin at different speeds depending on the burning task and the media being used. And it has to maintain these speeds with absolute precision.

Laser optics: This is an amazing assembly consisting of the laser, prisms, and servo motors for focusing and tracking the laser on the DVD or CD for reading and writing. The Sony DRU-510A pictured here can read/write to a staggering number of optical formats, including CD-R, CD-RW, DVD-R, DVD+R, and DVD-RW, among others. Each format has its own finicky positioning and burning requirements, which makes this assembly one of the most versatile of the mechanical components in your PC.

Loading tray motor: This motor controls the opening and closing of the drive's loading tray. A good motor should be quiet, and smoothly open and close the tray without funky rattling noises.



How To Pick the **BEST** DVD BURNER

Formats, shwormats...here's all you really need to know about DVD burning

If the launch of recordable DVD drives for consumers went the way it should've, this section wouldn't be necessary. But it didn't, and it is.

The good news is that choosing the right DVD burner isn't as difficult as it might first seem. In fact, we're going to *tell* you which burners are the best. But first, let's recap the individual DVD formats so you'll understand what all the fuss has been about.

DVD-RAM

DVD-RAM was the first recordable, rewriteable DVD standard introduced at the consumer level. DVD-RAM discs hold up to 4.7GB per side, so double-sided discs can hold up to 9.4GB per disc. In our opinion, the format wasn't particularly well thought out. Although the discs themselves resemble typical DVDs, they are encased in cartridges. *Ick.* DVD-RAM wasn't designed to be compatible with set-top DVD players, so you couldn't author your own videos to play for a bunch of bored

house guests. And although you can remove the discs from the cartridges, there isn't much point, because not even DVD-ROM drives can read the discs without support for the MultiRead2 spec, which is common today, but wasn't back when DVD-RAM was introduced. The format lives on today as a storage and backup device for businesses. In this regard, the cartridges are an effective deterrent against wear and tear. But for home use, there isn't much argument for DVD-RAM.

DVD-R/W

The write-once DVD-R format was developed by Pioneer Electronics and had the distinction of being the first format that offered some compatibility with set-top players and DVD-ROMs.

We say "some" because not all DVD readers could handle the subtle differences between commercially "stamped" DVDs and the less reflective DVD-Rs. DVD-R discs hold 4.7GB per side, although double-sided discs are rare.

Pioneer introduced rewriteable DVD-RW discs two years later, but the thrill of being able to reuse media was mitigated by DVD-RW's far lower compatibility with set-top players and DVD-ROM drives compared with the write-once DVD-R.

DVD+R/W

Although Pioneer's DVD-R/W technology worked fairly well as a consumer format, other manufacturers balked at having to pay Pioneer for every drive they produced and sold. So a cadre of companies including Sony, Philips, and Hewlett-Packard got

Sony's DRU-500A was the first burner to offer both leading DVD formats in a single drive.

together and created their own format. The first DVD+RW drives appeared in March 2001, accompanied by a huge marketing push that touted the technical advantages of the format, such as "lossless linking" and "defect management." But the rewriteable 4.7GB discs had an even lower rate of compatibility with set-top players and DVD-ROMs than did DVD-RW.

The write-once DVD+R format was released later in the year. Although DVD+R offered greater compatibility with other players, many early adopters of recordable DVD drives were surprised to find that their drives weren't upgradeable to the new format, even though some manufacturers suggested they would be able to do just that.

Let's see: a confusing VHS vs. Betamax-style standards slugout, broken promises, and compatibility issues. Talk about a traumatic birth. What kept the momentum going for DVD burners despite all of this was plummeting prices. Once sub-\$300 burners were released (not to mention software packages that decrypted and copied commercial DVDs), the prospect became irresistible. Which led to yet another embarrassing problem: product returns. Happy consumer walks into a store, buys a DVD-RW drive, and then picks up some DVD+RW media on his way out, not realizing that the two different standards are incompatible. The disc won't work in the burner, so the whole kit and caboodle is brought back to the store for a refund. How do you impress upon people the differences between formats? You don't. Hence, the introduc-



DVD-RAM starts to look good for home use only when it's combined with DVD-R, as in Panasonic's MultiDrive II.

tion of the dual-format DVD burner.

Sony was the first to bite the bullet with the DRU-500A, a sparkling, silvery beaut that wrote to both DVD+R/W and DVD-R/W discs. It was the first DVD burner to allow consumers to experiment with different types of media to figure out which format or formats were most compatible with their players. In our experience, DVD-R remains the compatibility leader for DVD Video, while DVD+RW is the most efficient for data storage and retrieval.

Today's dual-format DVD burners are ringing in at less than \$300, and 8x burners should be available before the ink dries on this page.

Now that the format issue is moot, you need only pick your manufacturer. Read on for our top picks in dual-format DVD burners.



Sony's DRU-500A was the first drive to offer both leading DVD formats in a single drive.

DOUBLE-SIDED VS. DUAL-LAYER

Double-sided DVD-RAM discs can hold up to 9.4GB of data and video, but you have to literally flip the disc to access the latter half of the information. Commercial DVDs can also hold up to 9.4GB of data and video, but disc-flipping is unnecessary. That's because they have two layers: When the end of one layer is reached, the reading laser adjusts its focus to zoom onto the second layer of the disc. That's why, on some very long movies, you'll notice a brief pause or stuttering as the laser adjusts itself to read the second layer. In *Titanic*, this happens just after Leonardo de Caprio gets hauled away for stealing the necklace.

Home DVD burners can read dual-layer discs, but can't create them. If anyone is planning to make a consumer DVD burner that can create dual-layers discs, they're not talking about it.

top picks

Pioneer DVR-A06

The DVR-A06 has the distinction of being the fastest DVD burner we've ever tested. We packed 4.25GB of data onto a DVD-R disc in 14:20 (min:sec), and the same amount of data to a rewriteable DVD+RW disc in 22:13. But what you really came here for is the thrill of burning your own DVD Video, isn't it? Pioneer takes the cake in this category as well. Although the bundled Ulead *MovieFactory* doesn't have some of the fancy features available in Sonic's *MyDVD 4.5* (like groovy full-motion backgrounds in menus), it has a transcoding engine that converts files into the proper format for burning much faster than *MyDVD*.

Surprisingly, the A06 is also a fast and flawless audio ripper, extracting more than 74 minutes of tracks from a commercially pressed audio CD in a mere 3:10, which is sure to infuriate the RIAA.

Unfortunately, the A06 is bogged down by last year's CD burning speeds, writing to CD-R at only 16x and reading CD-ROMs at a relatively pokey 32x. If you already have a fast CD burner this isn't a big deal. Otherwise, take a look at the closest competitor, Sony's DRU-510A.



Sony DRU-510A

Although Sony's dual-format DVD burner isn't quite as fast as Pioneer's DVR-A06, the differences aren't dramatic—just over 30 seconds writing to a DVD-R disc, for example. The DRU-510A outruns the A06, rewriting to DVD+RW at 4x (instead of 2.4x writing with the Pioneer drive), and supports CD burning up to a brisk 24x, and CD rewriting up to 16x. The drive did spin down some at the extreme outer edges of our music CD during the ripping test, but CDs are rarely packed this full, and the drive still clocked in at 3:38 (min:sec).

We love the bundled *MyDVD* disc authoring program. *MyDVD* allows you to import your own background and menu graphics, supports looping videos for chapter buttons and looping background audio, and throws in some acceptable templates if you aren't feeling ambitious. And the drive itself, with its transparent plate over a silver bezel, is a handsome addition to any habitat.

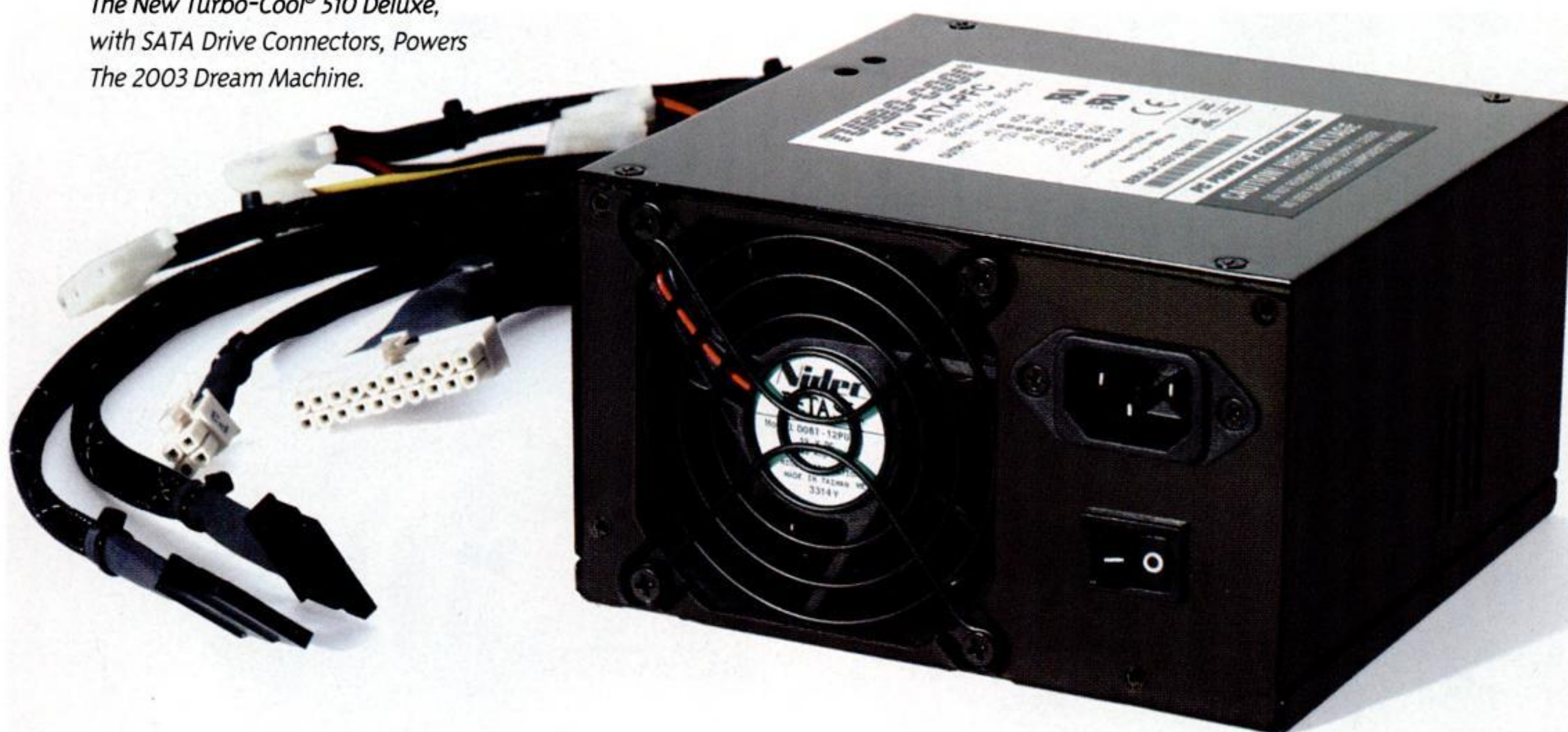
The DRU-510A, with its superior CD burning times, makes a better all-in-one drive than the A06; in fact, it's a perfect complement to a compact Shuttle box.

If you can wait, however, drives that burn to write-once formats at 8x—including ones from Sony—are just around the corner.

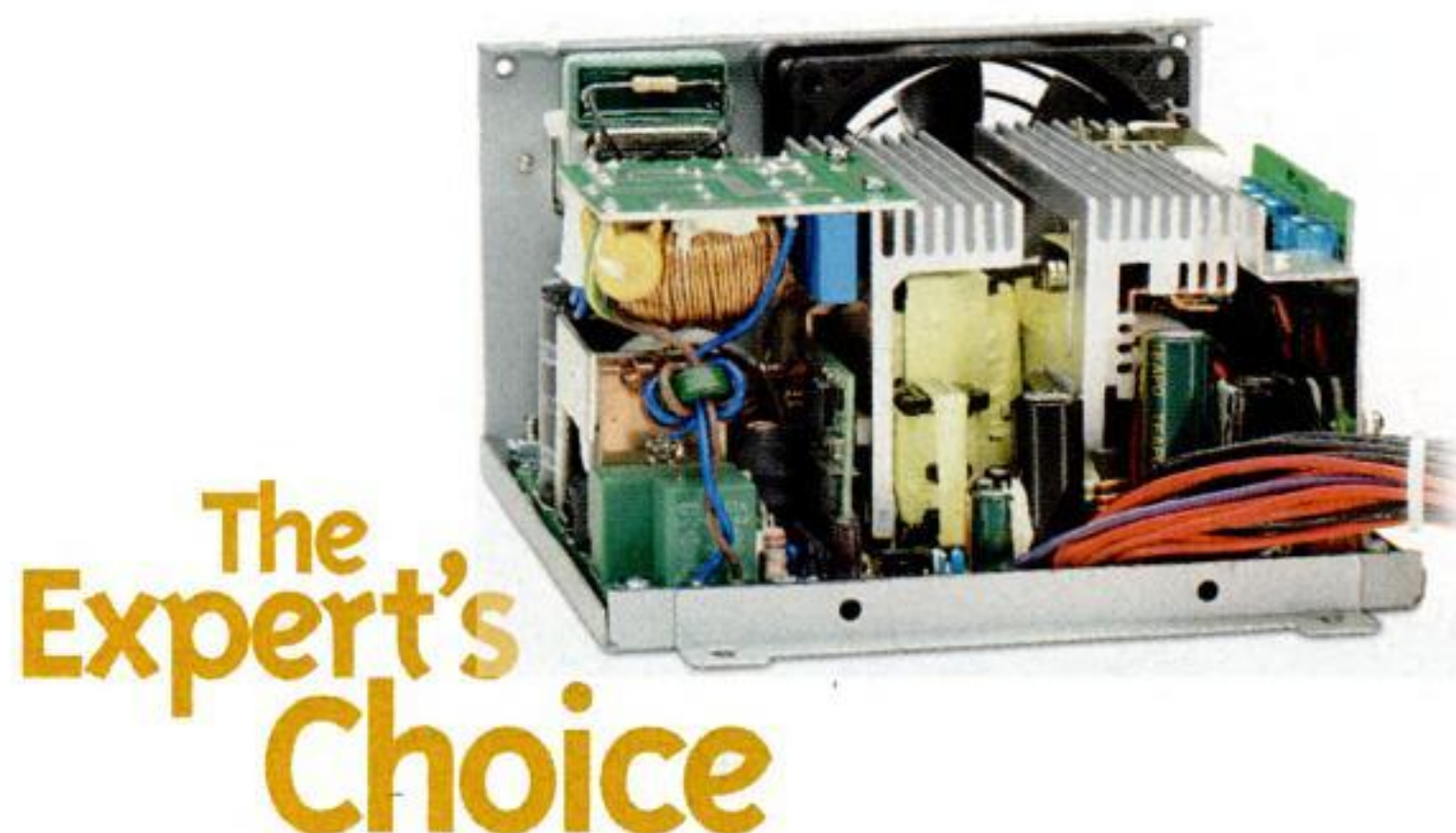


1999, 2000, 2001, 2002, 2003

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POWER SUPPLY

Output capacitors (underneath): Essential for system stability, these help the PSU provide the excess muscle required when the electrical demands from your PC's components suddenly changes, such as when two optical drives spin up simultaneously.

Heatsinks: Transistor switches and power diodes in the PSU produce loads of heat. The heatsink helps whisk away the heat from these components, a vital task considering that a power supply becomes less efficient as its temperature rises.

Line-conditioning circuitry: This is another of the phalanx of components within your power supply that help maintain consistent power levels from notoriously unreliable home sockets. Generally, you'll find line-conditioning circuitry only in top-tier power supplies.

Input capacitor: Usually the largest capacitor in a PSU, this provides reserve power when input power suddenly plummets (like, for example, when someone fires up the blow-dryer). In fact, it's one of a battery of devices built into a power supply (including the EMI filter and line-conditioning circuitry) that are intended to compensate for the unstable and interference-prone electricity from common household power outlets. In general, the bigger the capacitor, the better.

Power factor correction circuit: Computers, like many electrical appliances, draw a lot more power at the instant they are turned on—as much as four times the amount drawn under regular use. While this spike in power demand lasts just a fraction of a second, it may be enough to trip a circuit breaker in a home or office that has numerous electrical appliances. The duty of the power factor correction circuit is to smooth out this initial spike as much as possible, reducing its amplitude and preventing circuit overloads.

Fan: Heatsinks alone are not enough. The fan is necessary to prevent your power supply from becoming an EZ Bake Oven.

Electro magnetic interference (EMI) filter: Found in better power supply units, EMI circuitry smooths out the small fluctuations in the incoming AC current.

How To Pick the **BEST** POWER SUPPLY

Don't starve your prized components of power!

You don't hear a lot of folks bragging about the power supply in their custom rig. With the frantic arms race between AMD and Intel, and the leapfrog of one video-card technology over another, it's easy to forget the basic necessity of a steady and ample supply of power.

Granted, even the brawniest power supply unit (PSU) won't yield an extra ounce of computing power, but an inadequate power supply could result in unreliable operation, component damage, or even the inability to boot your PC in the first place.

If you don't want to get into the nitty-gritty of power supplies, we understand. Here's some simple advice: You'll want at least a 350-watt PSU from a *name-brand* company like PC Power and Cooling (www.pcpowerandcooling.com), Antec (www.antec-inc.com), or Enermax (www.enermax.com.tw).

But if you want to get down and dirty with us, here's some clear guidelines that will help you select a PSU that meets all your needs.

GET THE POWER YOU NEED

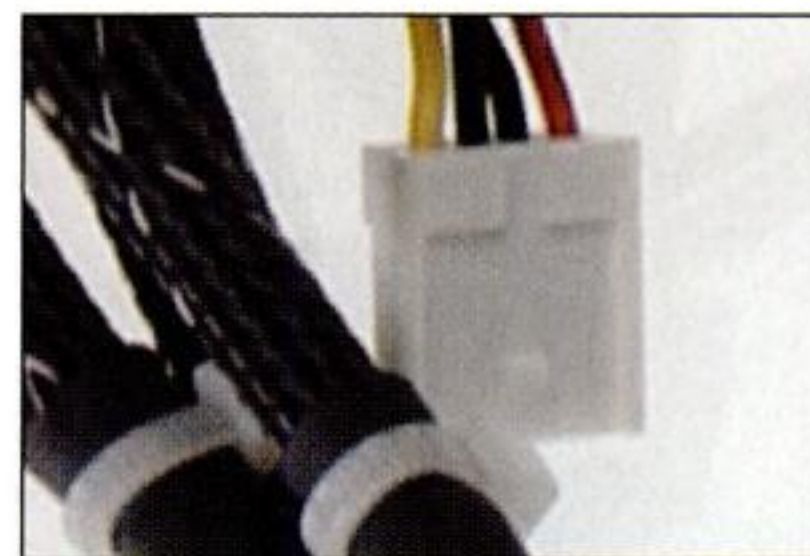
Before shopping for a PSU, it behooves you to first tally up how much power you need. You do this by adding up the power requirements of each component in your PC. Most components in your PC will display the power requirements (either on the part itself or in the documentation) in the form of voltage and current ratings. For example, a 7200rpm Seagate Barracuda 160GB hard drive has the following power information imprinted on it: +5V (volts) 0.72A (amps) and +12V (volts) 0.35A (amps). This means it uses both 5V and 12V power (one for the drive and another for the circuitry). First, we need to multiply the volts and amps of each line to find the total wattage the drive needs: 5 volts multiplied by .72 amps gives us 3.6 watts, and 12 volts multiplied by .35 amps gives us 4.2 watts, for

a total requirement of 7.8 watts. The drive should be given plenty of head-room, so we'll round this up to 10 watts total. Tally up the requirements for the rest of your components to find out the minimum wattage you need from your power supply.

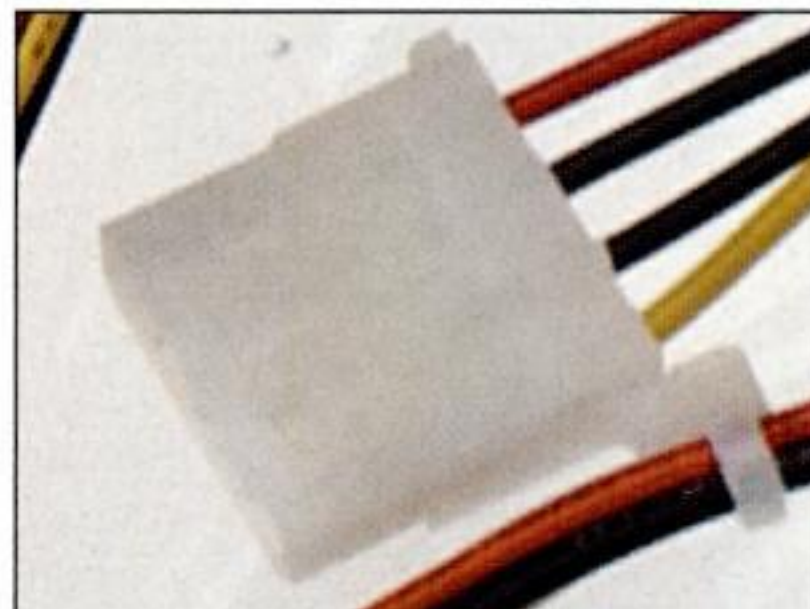
If you're upgrading, or just afraid of math, refer to the chart below to estimate the amount of power some components typically require.

When you are figuring out how much power you'll need, don't forget to leave plenty of room for the components you may want to add later, such as a second optical drive or a video-card that requires additional power beyond what the AGP bus can provide (some recent videocards demand as much as 50 watts!). In addition to the total power requirement of your system, it is often useful to calculate a separate power requirement for all the devices that use 3.3V and all those that use 5V power. This is helpful because most PSUs list a separate (lower) rating indicating the maximum power draw possible in each of these categories.

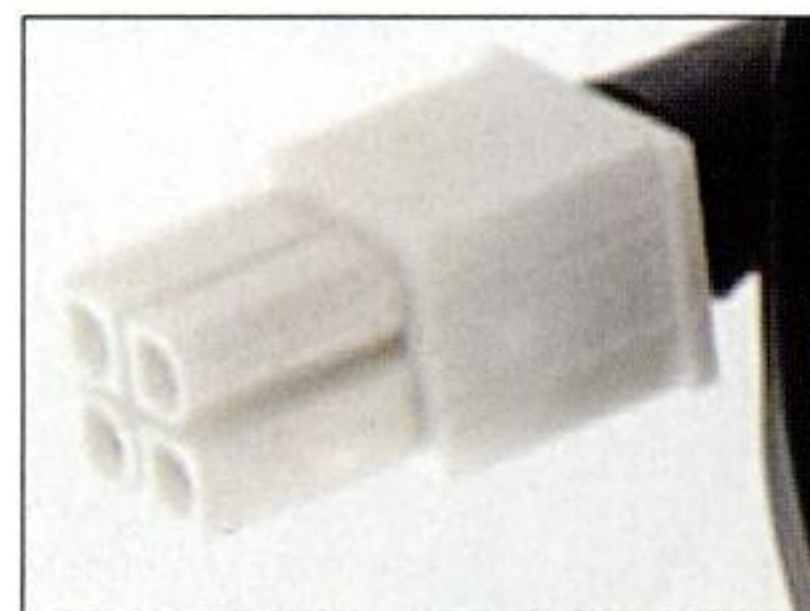
We can't emphasize enough how important it is to allow for plenty of



3.3 volt connector



5 volt connector



12 volt connector

COMPONENT	POWER REQUIREMENT	LINE(S) USED
P4 or Athlon XP CPU	70~90 watts	+3.3v or +12v
RAM	16 watts per 256MB	+3.3v
CD/DVD drive	10~20 watts	+5v and +12v
Hard drive	10~20 watts	+5v and +12v
Floppy	5 watts	+5v
AGP videocard	20~50 watts	+3.3v
Typical (non-video) PCI card	5~10 watts	+5v
Motherboard	20~40 watts	+3.3v, +5v, and +12v
CPU/case fans	2~4 watts	+12v

headroom—in fact, we recommend *at least* 30 percent more wattage than you've calculated. This provides more than just headroom for upgrades.

PSUs actually lose efficiency as heat rises. Remarkably, under a typical operating temperature of around 100° F, many PSUs can lose 25 percent or more of their posted power ratings! (The problem is that there is no legal or conventional requirement for a power rating to be accompanied by a temperature rating. That is, manufacturers aren't

required to say "This power supply outputs 400 watts—but only at 40° Fahrenheit."

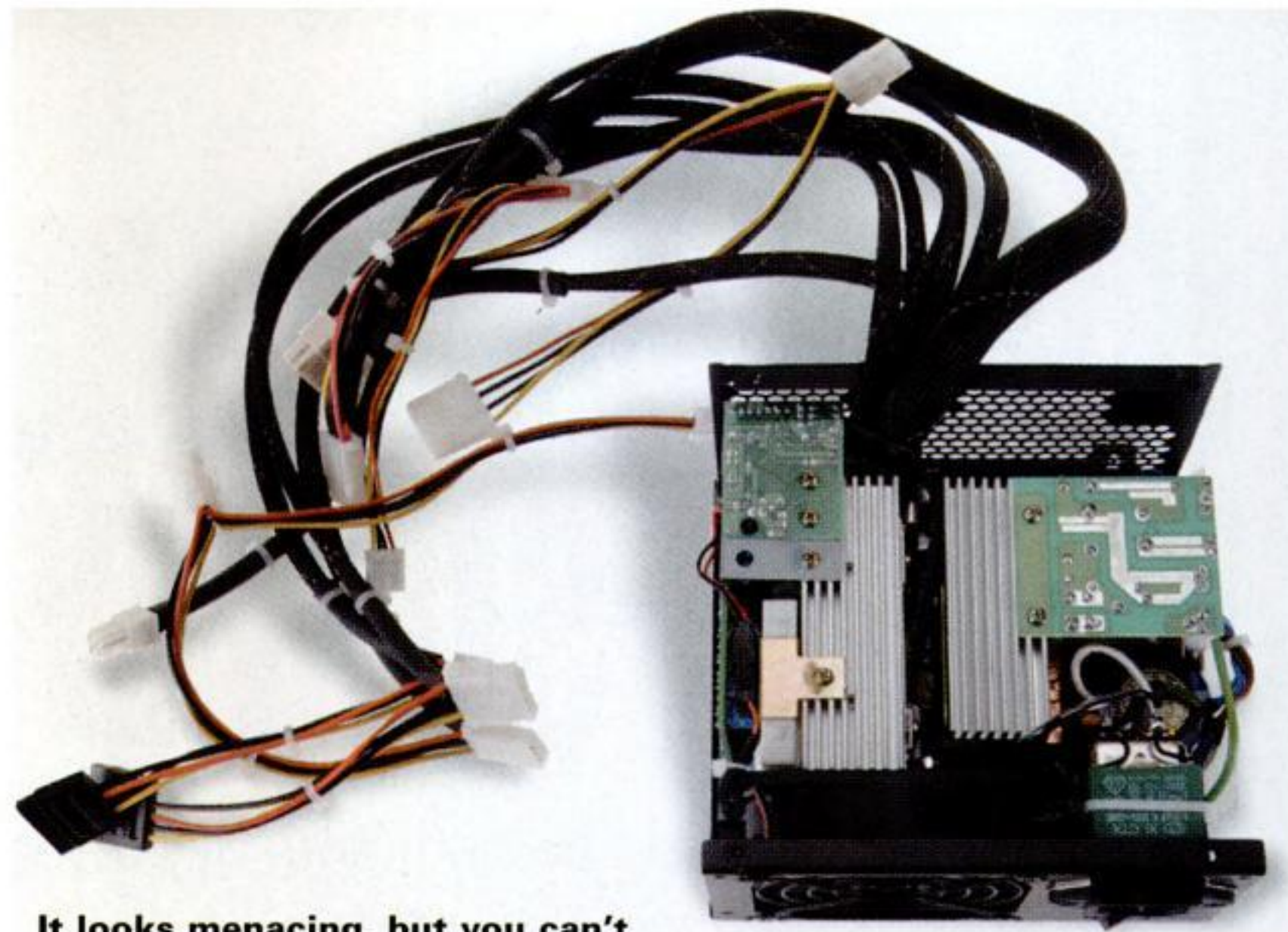
That's nearly freezing, and it's *never* that cold inside your computer. The truth is that the unit may only be worth 250W at a more likely 100° F!

The bottom line is that you should purchase a PSU with as high a power rating as you can afford, given that it has the features you want.

Contrary to a widely held misconception, a PSU with a higher rating *will not use more power than one with a lower rating*; both will draw only as much power as your components demand.

GET THE FEATURES YOU NEED

With the exception of very small or "slimline" designs, most PC enclosures accept a standard-size power supply. However, newer motherboards typically require a PSU that complies with the new ATX12V standard. These PSUs have the same dimensions as traditional power supplies, but they also include an additional four-pin 12-volt power connector and an increased wattage rating for +12V output. Therefore, if you're planning to build a Pentium 4 machine or any computer using a recent Athlon mobo—and you are, aren't you?—be sure to get a PSU with an ATX12V connector. In addition, if you plan on running a Serial-ATA drive, you'll need a PSU with the new Serial-ATA power connectors. It's possible to buy adapters that will allow you to use the standard



It looks menacing, but you can't accidentally plug a power connector into the wrong socket and blow up everything, because they're all different sizes.

hard drive power connectors, but there's a catch: These adapters will not supply 3.3 volt power. Although no Serial ATA drives require this voltage at this time, future drives may—and then you'll be out of luck.

For utmost reliability and stability—and especially if you're planning to overclock—you should also look for a PSU with line-conditioning circuitry. The power we get from the AC outlets in most U.S. homes and offices is full of ripples and spikes. This is just fine for your hair dryer, but can lead to harmful voltage instabilities in your computer. Line conditioners keep your system fed with clean, consistent power, thus reducing the chances of a brownout causing hard drive write errors or system lockups.

Because a power supply generates considerable heat, a good PSU should feature the more durable ball-bearing fan(s). These fans are less likely to get rattly or even fail over time. Ball-bearing fans are significantly more costly than conventional fans, so if a manufacturer puts one in a product, you can be sure that the packaging and/or documentation will state as much. Just be sure to look for it!

If you plan on using your system beyond the boundaries of North America, pick up a PSU that will accept both 110~120v (the U.S. standard) and 220~240v AC inputs. Many PSUs sport universal voltage capability as a fea-

ture. These can be identified by either a label stating their voltage compatibility range (e.g., 110~240v) or a switch in the back marked with two input voltages you can select from.

THE UNSCIENTIFIC METHOD

If you're trying to gauge whether or not to go with a lesser-known manufacturer, or if you can get away with the power supply included with your case, you may be surprised to know that weight is often a reliable indicator of quality. When it comes to the innards of a PSU, bigger is better. A good power supply typically has huge capacitors and beefy heatsinks. Hence, a good PSU usually has substantial heft, while featherweight units are likely to be system-damaging junk.

ELECTRON TALK

Voltage is a measurement of electrical potential difference, while current is the rate of the flow of electrons. Voltage is expressed in volts (V) and current in amperes (A). If you imagine electricity as water in a garden hose, voltage is the pressure of the water and current is the rate at which water is flowing.



If you plan to purchase Serial ATA drives, make sure you buy a power supply with Serial-ATA connectors, pictured above.

How To Pick the **BEST** **MOUSE & KEYBOARD**

Our input on your input

Yes, we've proselytized about the importance of every single component in your PC, and the mouse and keyboard, however unglamorous, are no exception. Think about it: The right keyboard can keep you merrily typing away after 10 hours at the office (we know this all too well). The wrong keyboard can put you in the hospital. The right mouse can make you the badass *Counter-Strike* god; the wrong mouse will have you serving snacks to your compadres after they've owned you in deathmatch.

Please, *please*, dump the craptacular \$3 mouse and \$10 keyboard that came with your PC. By now, you're probably tired of hearing about the freaky mechanics of every component. Well, you're in luck. Choosing a good mouse and keyboard for optimum gaming and ergonomics is pretty easy.

The keyboard part doesn't require any brainwork. Go to the store and fiddle with them all—standard keyboards, split keyboards, quiet ones, "clicky" models. Keep going until you find one that's comfortable. Even the *slightest* discomfort you feel is going to be magnified several times over within an hour or two of typing. Many keyboards also offer bells and whistles like multimedia control, wireless transmitters, and the like. If you want those features, great. But *only* on those keyboards that pass the comfort test.

Now on to our little rodent friends. There are a few things every mouse should have. Three buttons are absolutely mandatory, as is a scroll-wheel, preferably positioned in the center of your mouse. More buttons are optional, but not required. Truth be told, we don't use them that often, even though they can be extremely handy for web designers and *Excel* wonks who can program the buttons to do all sorts of parlor tricks.

In addition to the aforementioned prerequisites, there are really just two other things to consider before pur-

chasing a mouse: comfort and accuracy.

Comfort's self-explanatory. You want a mouse that's sized for your hand, has buttons within easy reach, and can be used for extended periods without discomfort. If your fingers seize up after a marathon *Rise of Nations* session, you're going to have serious carpal tunnel problems down the road. If a demo unit is unavailable, don't hesitate to take your prospective mouse out of the package right there in the store. Fondle it. Skim it across the display shelf. Knock yourself out (not literally, of course).

Gamers need an optical mouse that senses movement via a small beam of red light at the base. These can be far more accurate than the old-fashioned roller-ball mice, which have to be cleaned periodically (another chore you don't need). But not all optical sensors are created equal. A slow optical sensor will turn your smooth-as-buttah mouse move-

ments into stuttery cursor spasms. Not everyone measures mouse responsiveness the same way, but testing a mouse for gaming is easy. To test the rodent, firmly grab it, then move it from one side of your mousepad to the other as fast as you can. Watch the cursor as you do this. If it matches your movements across the screen, the mouse is golden. If it jumps madly across the desktop, ditch that mouse for another one.

Some of us are driven crazy by the constant tug-of-war with mice cords, so cordless mice can be a relief. But cordless-mice manufacturers have been slow to provide transmission rates sufficient for gaming. In fact, we think there's only one cordless mouse that comes close to performing well enough for gamers, and that's the Logitech MX700 (reviewed below). Most other mice sacrifice update frequency for longer battery life, and the result is piss-poor game performance.

top pick

LOGITECH MX700 CORDLESS OPTICAL MOUSE

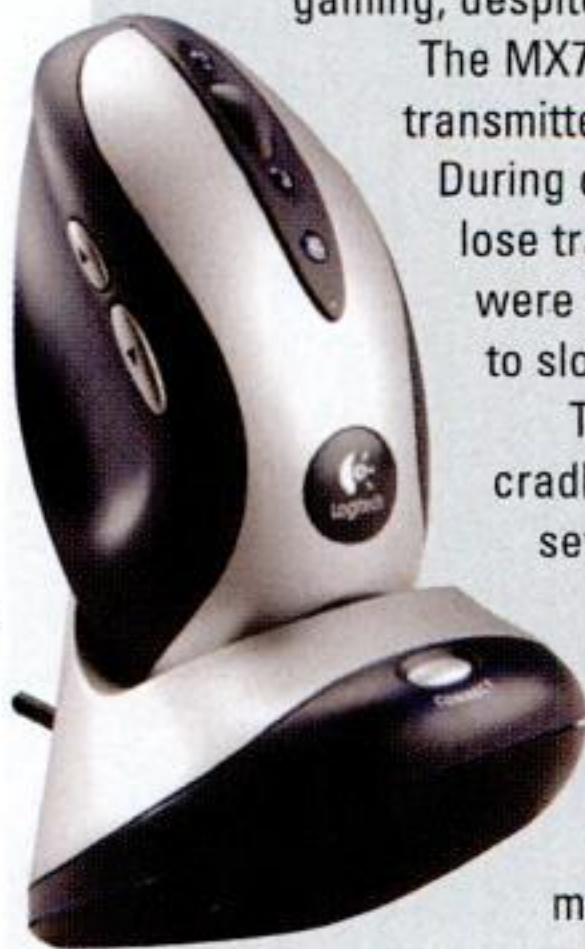
Gaming. Cordless. Mouse. Three tastes that just don't go together. But fortunately for the gaming public, the folks at Logitech didn't get the memo about "New Standards in Cordless Mouse Ineptitude." Quite extraordinarily, the MX700 is actually suitable for gaming, despite its cordless character.

The MX700's main features are a high-resolution 800dpi sensor and a radio transmitter that sends updates at 125Hz, just like a normal wired USB mouse. During our extensive testing process, we weren't able to make the MX700 lose track of its position, even when we moved the mouse as fast as we were able to. Neither the refresh frequency nor the update rate seemed to slow down.

The MX700 includes rechargeable NiMH batteries and a recharging cradle. It took about an hour to charge to full, and that charge lasted for several days of normal mousing. Button layout on the MX700 is solid.

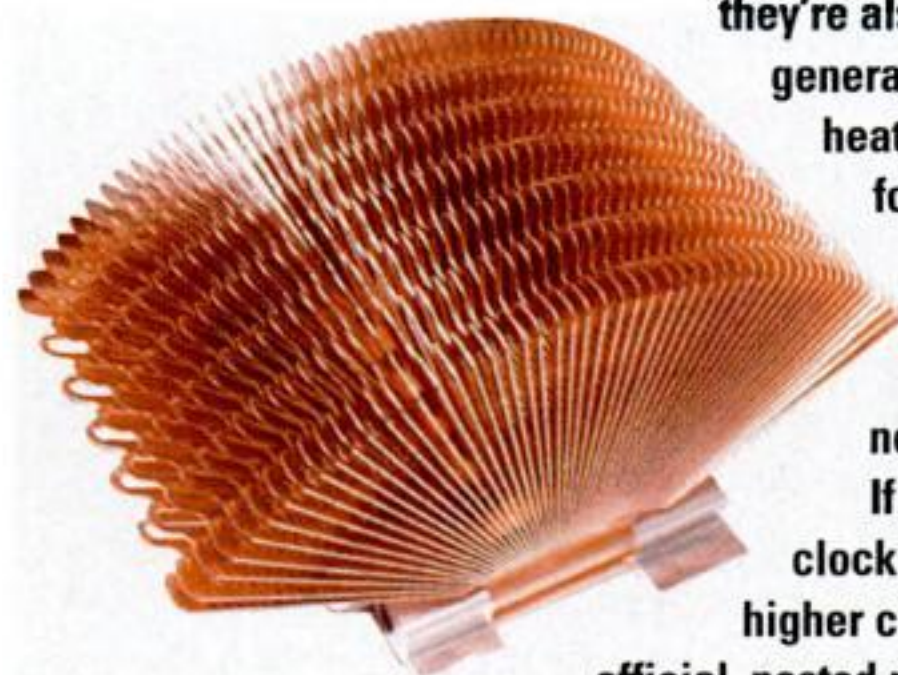
The two main buttons and the wheel are easily accessible, and the two thumb buttons are simple to use. The Logitech also has three extra buttons that can be programmed to serve any function you'd like.

If you're looking for a new mouse and cordless is a requirement, the MX700 is really the only choice.



How To Pick the **BEST** COOLER FOR YOUR CPU

Fever reducers for your binary reactor!



The more surface area your heatsink has, the more it will be able to transfer your CPU's heat to the air inside your case. Hence the "blooming flower" design of Zalman's CNPS6500B-CU.

Modern CPUs pack millions of transistors into a tiny amount of space. As a result, they're not just highly advanced silicon brains, they're also intense furnaces that generate massive amounts of heat. And heat reduces performance, introduces instability, and can seriously abbreviate the life of your components.

If you don't plan to overclock your CPU (running it at a higher clock frequency than its official, posted rating) you'll most likely be satisfied with the heatsink and fan combo that came with your CPU. But if you intend on raising some overclocked hell with your processor, or if you bought a "bare" CPU in some shady back-alley deal, you'll need to devise your own cooling strategy. Here's how to go about it.

FUN WITH CLASSIC AIR COOLING

The job of any CPU cooling setup is to move heat from your CPU and dissipate that heat into the air. Heatsinks squat directly on your CPU and transfer heat from the die (or, in Intel's case, a heat spreader plate) to its fins or spires, which

pass the heat into the air, which should then be swept out of the case by your case fans (as long as airflow isn't obstructed by tangled cables and whatnot).

There are four major factors affecting cooler performance: the kind of metal the heatsink is cast from, the design of the radiating fins, the fan (if present as part of a heatsink/fan combo), and the contact surface between the heatsink and the CPU.

As far as the material goes, copper is the finest material a heatsink can realistically be made from. It's the third-best conductor of heat after silver and diamond, which are somewhat more expensive. So look for a cooler with a copper heatsink, or at the very least, a heatsink with a copper contact plate.

Heat is dissipated from the heatsink through contact with air, so the more surface area on your heatsink, the better. That's why you want to look for heatsinks with numerous thin fins or spires rather than a few thicker ones.

A heatsink alone won't cut it for overclocked CPUs. A heatsink/fan combination will wick the heat off the heatsink radials much faster. Keep in mind, however, that the

bigger the fan, the more noise it's likely to make.

Finally, it's important that the surface where the cooler contacts the CPU be as smooth as possible. Although the base of a heatsink may look smooth to your eye, it's actually replete with microscopic gaps and crevices that inhibit maximum heat transfer. That's where thermal paste enters the picture. Thermal paste, like our preferred Arctic Silver 3 (www.arcticsilver.com), fills in these tiny gaps to improve the conductivity of your heatsink. But don't go crazy with this stuff; more is *not* better here. When applying thermal paste, apply just enough to create a *very* thin film over the CPU. Remember, we're just trying to fill in microscopic gaps, not to smother your CPU or clean up goop that spills out over your mobo's circuitry!

HARDCORE COOLING FOR HARDCORE GEEKS

Good heatsink/fan combos can be very efficient, but they may not be good enough for hardware fanatics who plan on pushing their CPUs to insane speeds. If you fall into this category, you should consider more robust cooling options. One is water cooling.

Water-cooling systems send liquid to "heat blocks" attached to your key components (candidates include your CPU, GPU, and hard drive). The cool liquid draws heat away from your searing component, then transports it to some type of cooling device (usually a fan-cooled radiator), which dissipates the heat outside of your case. The liquid is circulated through each heat block with the help of

AMD FANS BEWARE!

Massive heatsinks may look impressive, but we've seen many tragedies involving colossal contraptions that have been slapped onto delicate AMD CPUs. Unlike Pentium 4 processors which are protected by thick metal heat spreaders, AMDs have exposed cores that are easily damaged by applying too much pressure to the CPU when

locking down the heatsink. A single scratch could take out a whole neighborhood of transistors, while a fracture could mean a very short life for your CPU. AMD's specification for Socket A processors requires the heatsink and fan combo to be no more than 300 grams. But even with a cooling setup lighter than this, be careful to latch it down slowly while applying steady pressure.

a pump—the literal heart of the water-cooling system. This ticker, usually a high-end fish tank pump, can cycle the equivalent of a thousand of gallons a day throughout your rig.

The water within a heat block can absorb four times the heat of a traditional heatsink/fan combo. Even better, it can transfer heat 30 times more effectively than regular cooling methods, and doesn't produce excessive noise. In short, water-cooling is an extremely effective tool for overclockers—it not only cools key components, it also helps keep heat away from your case's general interior. That said, be aware that there is, after all, liquid running through your system. If it's installed incorrectly, or if there is a manufacturing defect and a circulation tube pops loose, well, there goes the neighborhood.

There's another way to achieve overclocking-class cooling that doesn't involve a fish-tank pump. It's called phase-change cooling, and to understand how it works, you'll need to brush up on some basic physics.

A "phase change" occurs when matter shifts between any of its liquid, gaseous, or solid states. For example, water phase-changes when it turns to ice in your freezer, when it boils away in a cooking pot, and when steam condenses back into water.

In order to change from liquid to gas, water (like all matter) needs a significant amount of energy. At room temperature, for example, one gram of water needs just one calorie of energy to increase in temperature by 1 degree Celsius. But at 100 degrees Celsius (the boiling point of water), water needs to absorb 540 times that



No, this isn't a menacing lab experiment—it's the apparatus for a water-cooling kit, including water blocks for videocards and hard drives.

amount of energy to phase-change into steam. Conversely, all that energy is released again when the steam vapor condenses back into a liquid.

Here's the plot twist that makes phase-change cooling possible: Boiling and condensation can be forced to occur by manipulating pressure, and if you put water in a container holding a vacuum, the water will boil at a lower temperature than it would at regular room pressure. Water in this vacuum still requires 540 calories of energy to convert to steam, and it will absorb this energy from the most convenient heat source—such as a scorching-hot CPU. Fantastic, yes, but true: By boiling refrigerant over your CPU and "stealing" its heat energy to do so, the processor is cooled.

Now *that's* exotic cooling, and the prices reflect it. The most effective phase-change cooler we've tested is Chip-Con's Prometeia (www.chip-con.com), and it'll set you back about \$600.

top picks

Vantec Tornado TD8030H

Vantec says this beast moves 84 cubic feet of air per minute. We bet the AC in your Honda Civic doesn't move that much air.

In order to completely upend the microclimate of every host case it enters, the Tornado spins at a whopping 5700rpm. As one might expect, the tornado is loud.

We can't argue with the numbers: The Tornado yielded more cooling than any other case fan we've ever encountered. If you want to stuff your rig to the brim, you've found your boy.



Alpha PAL 8942T

This intimidating P4 heatsink is constructed of black anodized aluminum and features a copper base.

While the CPU was being hammered by CPU Burn-in at 2GHz, the Alpha kept it downright chilly at 93 degrees—9 degrees cooler than stock cooling. When we stepped it up to 2.3GHz for another half-hour-plus of CPU hell, the temp topped out at 96 degrees, making the Alpha the only cooler that could keep a P4 from breeching 100 degrees under maximum duress.

That said, the Alpha was the most time-consuming P4 cooler to install.



Koolance Exos

The Exos was the best-performing water-cooling system we've ever tested. The kit's entire functional system is housed in an external unit that's home to a Koolance fan control unit, dual custom-built submersible water pumps, and three 80mm fans perched atop a radiator. The only thing not residing in the external unit is the Koolance CPU heat block. Water passes from the heat block to the outside unit and back again via a clever PCI slot cover modified with holes for water tubing.

In the business for eight years, Koolance has a mature product that's ready to be integrated swiftly and easily into any system.



Chip-Con Prometia

Standing tall and proud, the Prometia full tower is the most powerful mass-produced PC cooling system ever built.

This thing runs Ice Age cold. After overclocking our CPU and running it at full steam, we were able to hit 3600MHz at 5 degrees Fahrenheit.

The Prometia has the polish to go along with its performance, too. The manual is well-written and complete with 3D illustrations, and putting the kit together is easy thanks to a fool-proof clamping system.

Everything important to the cooling system sits in a box that sits under the main chassis. So if you wanted to swap cases, you could simply drill a few holes for the mounting bolts and evaporator cables.



YOUR GUIDE TO



Reading the performance specs on a hardware box can feel like reading the menu at a French restaurant. If you don't actually understand the words on the page, you'll have no idea what you're about to sink your teeth into. And so go hardware specs. But choosing hardware doesn't have to be that tough. Simply learn the language of specs with our handy guide, and you'll never have to worry about buying something disgusting and distasteful. Sweetbreads, anyone? Bon appétit...

PHOTOGRAPHY BY ARNOLD TIOSEJO AND MARK MADEO

MONITORS



Viewable image size: The screen on any CRT features a perimeter that can't display actual colored pixels, so it's only fair that CRT vendors share information on a monitor's actual viewable image area. This area is always expressed as a diagonal measurement.

Dot pitch: A CRT's pitch refers to the distance between two neighboring phosphor dots of the same color. This spec is always described in fractions of a millimeter and is usually measured diagonally. Smaller numbers are always better, because the closer the dots are to each other, the crisper the picture will be. Shadow-mask monitors boast a dot pitch, while aperture grilles boast a stripe pitch. Be aware that some shadow-mask monitor vendors define pitch as a horizontal dot pitch, yielding a number that's a bit smaller than the traditional diagonal pitch measurement. To wit: A monitor with a 0.28mm dot pitch will boast a 0.24mm dot pitch if measured horizontally. Caveat emptor.

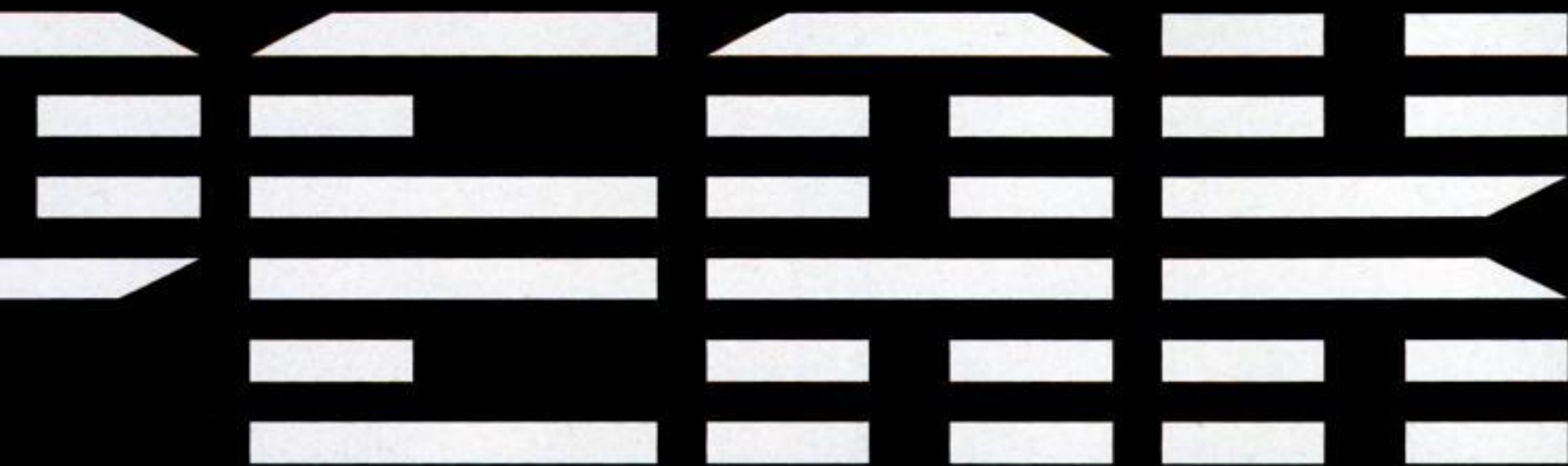
Maximum refresh rates: As you increase a monitor's resolution, its refresh rate will drop accordingly. For this very reason, maximum refresh rates and resolutions are usually grouped together in the same spec slot. These numbers should always be as high as possible—you never want to see low refresh and resolution specs. Ideally, your monitor will still be able to support high refresh rates (85Hz and above) at its highest resolution settings. Refresh rates below 75Hz can cause a flickering effect that will eventually strain your eyes. As for resolutions, 1600x1200 is considered the lowest "pro-level" resolution acceptable for serious graphic design work.

Tube: Many CRT companies like to pimp the specific, trademarked name of their monitor technology. Because these hyperbolic names often impart little information about the actual product, skip this hoo-ha and zip on down to the "CRT type" entry.

CRT type: Here you'll learn some legitimately important information about the display—specifically, whether it's a shadow-mask or aperture-grille CRT (that's cathode ray tube, the same technology used in traditional television sets). Shadow-mask CRTs tend to be dimmer than aperture-grille CRTs and have more problems with color consistency (aka "screen mottling"). But shadow-masks do lack the two razor-thin horizontal lines found on all aperture-grille displays (some people find these lines to be distracting). Invar is an iron-nickel alloy that's used in the monitor's mask. The mask is essentially a perforated piece of metal that guides the monitor's electron gun to the precise phosphor dots it needs to illuminate.

Size: You'll most likely find 15, 17, 19, or 21 inches listed here. But the "size" spec only refers to the size class the monitor belongs to, not the actual viewing area.

- **Tube:** SupaFlat™ ZFT
- **CRT type:** INVAR shadow mask
- **Size:** 19 in.
- **Viewable image size:** 18.0 in.
- **Dot pitch:** 0.20mm (horizontal)
- **Maximum refresh rates:**
 - 640x480: 160Hz
 - 800x600: 160Hz
 - 1024x768: 155Hz
 - 1157x870: 140Hz
 - 1280x1024: 120Hz
 - 1600x1200: 100Hz
 - 1600x1280: 95Hz
 - 1856x1392: 87Hz
 - 1920x1440: 85Hz
 - 2048x1536: 75Hz



VIDEOCARDS

Chipset: It's the driving force behind everything your videocard is capable of. There are two chipsets worth considering right now: the GeForce line from nVidia and the Radeon line from ATI. The GeForce and Radeon lines each boast several subdivisions, so you'll find everything from \$80 budget cards to \$400 ultimate gaming cards under their umbrellas. Nonetheless, each card in each product line is based on the same chipset.

Memory size: All videocards include a certain amount of onboard, high-speed memory. This RAM is used to store information about the geometry of the 3D models the card is rendering, as well as the actual textures that are being stretched across those models. Many current games use the full 128MB that most cards offer and even take advantage of the extra space that a 256MB card offers. A 128MB card will serve you well for the next few months, but a forward-thinking buyer would get a card with 256MB to accommodate future games.

- **Chipset:** ATI R300
- **Memory size:** 128MB
- **Memory type:** 256-bit 330MHz DDR SDRAM
- **RAMDAC:** 350MHz
- **Max resolution:** 2048x1600@85Hz

Memory type: The first portion of our example (256-bit) refers to the amount of data that the card's memory can transfer each clock cycle. Most videocards support 256-bit, 128-bit or 64-bit transfers—the larger the number, the better.

The second number is the speed rating of the memory in megahertz. A larger number is better here as well.

Memory can be single data-rate (SDR) or double data-rate (DDR). SDR memory can complete one data transfer per clock cycle. DDR can complete two, making it effectively two times faster than SDR memory of the same frequency.

When you put all of the memory specs together, they essentially tell you the maximum theoretical memory bandwidth of the card. For example, this card is able to transfer two 256-bit chunks of data 330,000,000 times every second, yielding a maximum theoretical memory bandwidth of 21.12GB/sec.

RAMDAC: The RAMDAC (random access memory digital-to-analog converter) converts the digital signal produced by the videocard into an analog signal that a CRT monitor can display. The faster the RAMDAC, the higher the maximum resolution and refresh rate that the videocard can drive.

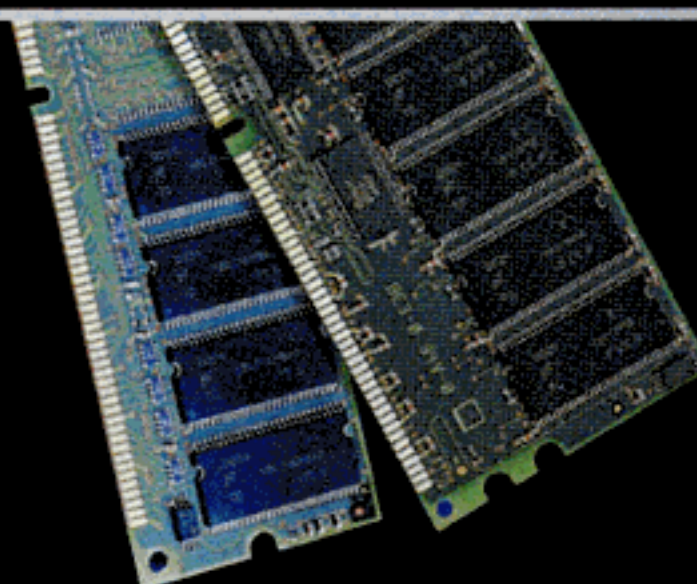
Max resolution: This is the maximum resolution and refresh rate that the videocard will drive, and is a direct function of its RAMDAC speed. Most modern videocards should be capable of running 1600x1200 at 85Hz or faster.

NOTE: A videocard's spec box won't typically define which specific 3D visual effects the card supports; this information usually appears on a different part of the product packaging. For information on what terms like "anisotropic filtering" and "24-bit Z-buffer" mean, check out our guide to 3D terms in the June 2003 "Videocard Answers" feature in *Maximum PC* magazine.

Because all spec boxes are different—after all, vendors are going to highlight the specs that make their product look best and avoid those that make it look bad—what you'll see here are "spec lists" we created to deliver details on as many specs as possible. You may not see all of our examples on a given box, but you'll definitely see them as you look over multiple boxes.



MEMORY



Capacity: This is how much memory is installed on the PCB (printed circuit board—the green board that the memory is stuck onto). RAM slots on most PCs are sparse, so you should try to purchase large-capacity modules whenever possible. In other words, if you want a 256MB upgrade, buy a single 256MB stick instead of two 128MB sticks. This way, you'll still have an open slot for another upgrade in the future.

Formfactor: This refers to the actual physical form of the memory module. Our example has a 168-pin connector and is identified as a DIMM (dual inline memory module). Different mobos are built to house different memory formfactors, so you'll need to refer to your system documentation or peek at the motherboard to determine exactly what kind of RAM you need.

ECC/Parity: Parity memory can detect compromises in data integrity, while ECC (error correction code) memory is not only able to detect errors, but can also correct them. Data-integrity schemes in memory modules are on their way out in most systems, with the exception of critical high-end servers. ECC and parity memory modules are more expensive than traditional memory, and manufacturing processes over the past decade have vastly improved reliability among memory components, so you won't often see error correction offered on memory.

- **Capacity:** 256MB
- **Memory speed:** 133MHz
- **Formfactor:** 168-pin DIMM
- **Type:** PC133 SDRAM
- **ECC/Parity:** None
- **Voltage:** 2.5v
- **CAS latency:** CL3

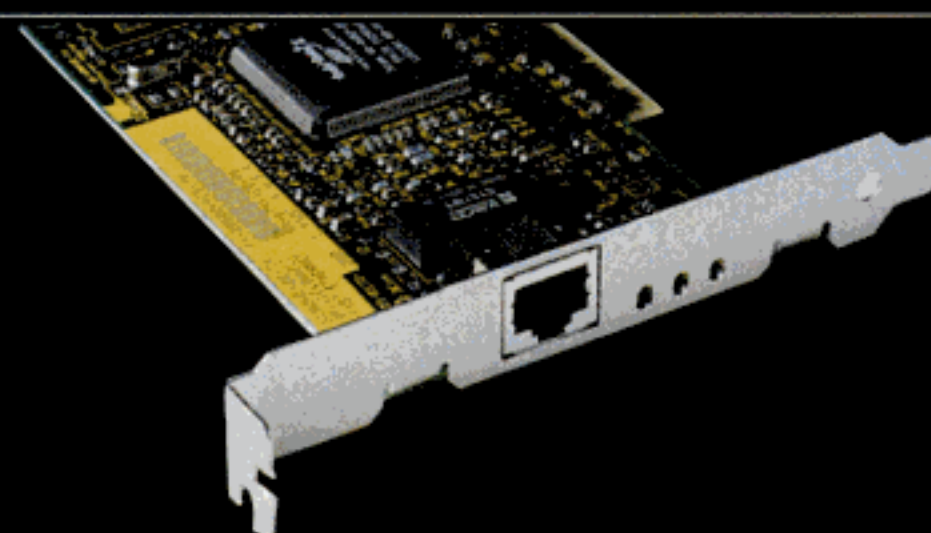
CAS latency: Column address strobe (CAS) is used in conjunction with row address strobe to locate information in RAM. The CAS latency, or CAS rating, refers to the number of clock cycles it takes to perform this locating function. A CL3 factor means it takes three clock cycles to locate information, whereas memory with a CL2 factor takes just two clock cycles. This doesn't mean you get 33 percent faster performance with CL2. In fact, the difference in most systems will be nominal. Still, memory-intensive applications and over-clocked processors may get a boost from lower latency ratings. You can mix CL2 and CL3 modules, but they'll all run at CL3.

Memory speed: There are two methods of classifying the speed of your RAM. Traditionally, memory speed has been measured in nanoseconds, with ratings that range from 80ns to 50ns. Lower numbers indicate faster access times. But SDRAM (synchronous dynamic RAM) memory chips synchronize themselves with your PC's system clock. (No, it's not the one that tells you the time; it's the one that sends out a regular signal, like a metronome, to which all of the machine's components can synchronize). As a result, the speed of most new memory modules is expressed in megahertz, just like your CPU. In this case, higher numbers are better.

Type: RAM type usually refers to the clock speed of the chips and the technology they use. Our example is SDRAM running at 133MHz. You can sometimes mix RAM configured at different clock speeds, but all modules will synchronize to the speed of the slowest module. Regardless, you'll need to refer to your system documentation to match up the proper RAM with your motherboard and processor.

Voltage: This is the amount of power your memory requires. Older systems used memory modules that operated at 5v, but these days, most RAM operates at 2.5v. Don't even think about using chips that can't operate at the voltage your motherboard requires.

NICs NETWORK INTERFACE CARDS



Standards: This lets you know what network protocols your card supports. Our example card supports the classic Ethernet 10BASE-T, which operates at 10 megabits per second, or 1.25MB/sec, as well as the beefier 100BASE-T that ups the throughput to a (theoretical) 100Mbps, or 12.5MB/sec. If that's not enough for you, there's always Gigabit Ethernet which ups the ante to a breathtaking 1000Mbps. Remember, though, that all nodes on your network share this bandwidth, so the actual throughput on any given machine will depend on the amount of network traffic.

LEDs: They're more than just pretty lights. Light-emitting diodes, or LEDs, can help you diagnose problems with your network. This card conveniently offers separate LEDs that indicate when data is being transmitted over a 100BASE-T network or a 10BASE-T network, as well as a handy extra light that illuminates when you're connected to the network and flashes whenever you're transmitting or receiving data.

- **Standards:** 10Mbps 10BASE-T, 100Mbps 100BASE-T
- **Interface:** PC PCI, Network RJ-45
- **LEDs:** 100Mbps, 10Mbps, Activity
- **Auto-sensing**
- **Wake on LAN**

Interface: This indicates how your NIC connects to your PC and your network. This card is intended for a PC PCI slot and requires cables with RJ-45 (registered jack) connectors. These connectors look like telephone jacks, but are slightly wider and hold up to eight wires each.

Auto-sensing: An auto-sensing card can identify whether you've plugged into a 100BASE-T network or a 10BASE-T network and configure itself accordingly. Without this capability, you'd have to manually switch the network through software or a hardware jumper.

Wake on LAN: Wake on LAN cards support ACPI (advanced configuration and power interface) remote wake up, which is a long-winded way of saying that they're capable of remotely powering up your Windows 98 or Windows 2000 PC.

OPTICAL DRIVES

Write/rewrite/read speed: Optical drives capable of burning to CD-R and CD-RW always indicate speeds in the AxBxCx format, in which A describes the maximum write speed to CD-R, B describes the maximum write speed to CD-RW, and C describes the drive's maximum data read speed. A speed of 1x is 150KB/sec, so data rates higher than this are multiples of this base figure. Needless to say, higher numbers are better across the board. Note that the maximum speed a drive can actually hit before physics begins to upset the process is around 52-56x. Drives that advertise faster rates, such as Kenwood's True-X drives, have multiple lasers reading simultaneously to achieve higher speeds.

Seek time: This is the amount of time it takes a drive to locate and deliver information. The lower the number, the faster the drive should be. But don't make this the determining factor in selecting a drive. Though most optical drives claim an access time of around 150 milliseconds, there really aren't any specific standards for measuring this type of performance.

Buffer underrun protection: If you're a CD-burning freak, buffer underrun protection is just about the greatest thing since Cocoa Krispies. Branded under such names as Burn Proof, SafeBurn, and JustLink, these technologies can pause recording when the data buffer is empty, then resume recording when it's been refreshed. These pauses, however, can extend burning times and are considered verboten by nitpicky audio-mastering professionals because they leave tiny gaps between data streams.

Recording modes: The options are as follows:

- **Disc-at-once:** Writes the entire CD in one pass. After writing, your disc is "closed" and you can't add any additional information.
- **Track-at-once or multisession:** CD can be written to in multiple passes at different times. However, until the disc is "closed," some players—especially consumer devices—may be unable to read the disc.
- **Session-at-once:** This hybrid mode allows disc-at-once control over gaps left between tracks by track-at-once recording. This method is often used when creating discs in the CD-Extra format, such as audio CDs that include digitized video.
- **Packet writing:** Formats your disc into small blocks of data holders, like a floppy disk. Data can be added or erased incrementally. Erased blocks can be reused on a CD-RW.

Flash upgradeable: Trust us, you want this. Flash-upgradeable optical drives have a chip similar to your PC's BIOS that can be "flashed" with new instructions from the manufacturer. These updates can fix bugs, improve performance, and add support for new CD formats.

• **Interface:** E-IDE (ATAPI)

• **52x32x52x**

• **DAE speed:** 40x

• **Seek time:** 140ms (reading)

• **Max data transfer rate:** 7,800KB/sec

• **Data buffer size:** 2MB

• **Buffer underrun protection**

• **Recording modes:**
Disc-at-once, track-at-once (multisession), session-at-once, packet writing

• **Formats supported:**
CD-DA, CD-ROM, Photo-CD, Video CD, CD-I, CD-Extra, CD-Text, CD-ROMXA

• **Flash upgradeable**

Interface: Internal optical drives use either the SCSI or EIDE (also known as ATAPI) interfaces. At the risk of bringing up the age-old SCSI vs. IDE brouhaha, most users will be perfectly happy with the cheaper IDE drives (though SCSI does have the advantage of dedicated controllers that don't place the burden of I/O tasks on your CPU, and the capacity for chaining more than two drives on a single cable).

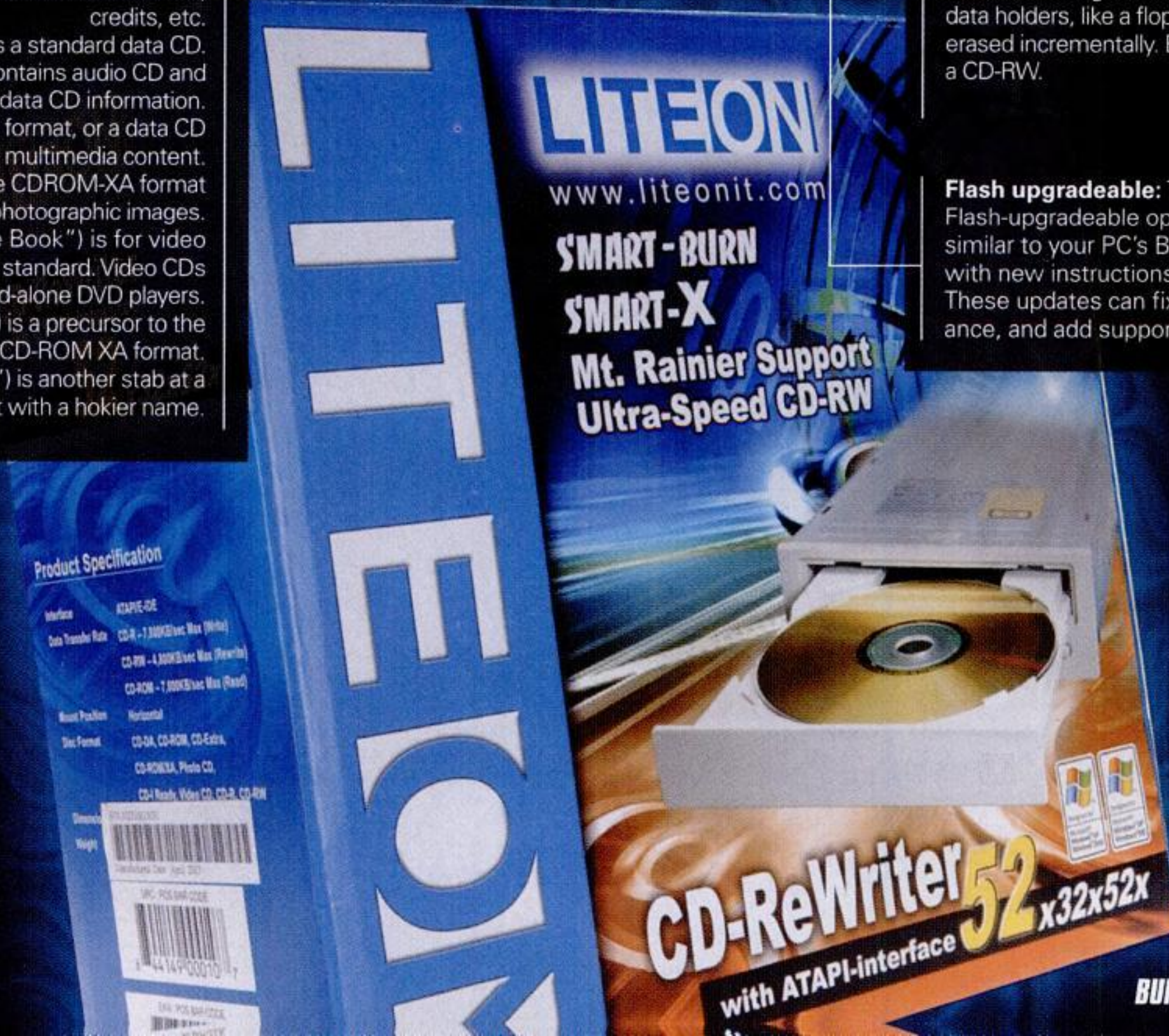
DAE speed: DAE, or digital audio extraction, indicates how fast an optical drive can extract tracks from an audio CD using the 1x=150KB/sec ratio. Again, higher numbers are better. DAE times tend to be slower than general read times because audio tracks on compact discs aren't recorded in the same way that files are recorded on a hard disk. The laser in your optical drive must not only decode the digital data, but must also use complex algorithms and error-correction bits to play a kind of guessing game about exactly where tracks begin and end.

Max data transfer rate: This is just another expression of the drive's maximum data-read speed. A 52x drive transfers 150KB/sec multiplied by 52, resulting in a maximum data-transfer rate of 7800KB/sec.

Data buffer size: Data buffers are crucial to preventing the buffer underruns that cause you to burn coasters instead of usable CDs. Buffers essentially ensure that a constant stream of information is available to your burner's laser. If the data buffer runs dry during the burning process, the laser stops recording, and the disc is ruined. When writing at 16x speed, a data-starved 2MB buffer can survive for just under a second before it drains completely. Buffer-underrun protection technology (such as Burn Proof) can eliminate the consequences of this problem.

Formats supported: Among the glut of formats out there, these are recognized by most optical drives:

- **CD-DA ("Red Book")** is a garden-variety audio CD.
 - **CD-Text** is an audio CD with extended text information containing artist and track names, credits, etc.
- **CD-ROM ("Yellow Book")** is a standard data CD.
 - **Mixed-mode CD-ROM** contains audio CD and data CD information.
- **CD-ROM XA** is a photo-CD format, or a data CD with interactive multimedia content.
- **Photo-CD** is based on the CDROM-XA format and is used to store photographic images.
 - **Video CD ("White Book")** is for video compressed in the MPEG-1 standard. Video CDs can be played by most stand-alone DVD players.
 - **CD-I ("Green Book")** is a precursor to the CD-ROM XA format.
 - **CD-Extra ("Blue Book")** is another stab at a mixed-mode format, but with a hokier name.



SPEAKERS



Frequency response: The sensitivity of the human ear ranges from 20Hz to 22KHz, and most speaker systems closely approximate that range. Speaker sets without subwoofers, however, may only reach down to 120Hz. Such a set can still pump out bass, but it probably won't rattle windows when you crank up the volume. Speaker sets that do include subs usually come with satellites that boast a frequency response of 150MHz to 250MHz—which is just fine, because the subwoofer takes care of everything below this range.

Crossover points: Take the dust cover off the front of a good stereo speaker and you'll usually see a little speaker (the tweeter) and a big speaker (the woofer). The crossover point is the boundary between the two—the tweeter handles all frequencies above that point, and the woofer handles all frequencies below. In a really good set of PC speakers, the crossover point falls around 200Hz. If individual satellite speakers have two speakers inside, the crossover point usually falls around 5KHz. Dolby Digital speakers have a subwoofer-to-woofer crossover point around 250Hz.

- **Frequency response:**
20Hz-22KHz
- **Maximum output:**
100dB at 20 feet
- **Crossover points:**
5KHz high-frequency crossover
- **Power output per channel or total power output:**
400W total output (25W midrange X 4, 85W subwoofer)
- **Input connectors:**
1/8 inch, S/PDIF, optical

Maximum output: Audio volume is stated in decibels, a figure that's calculated with a complex formula that takes into account the distance between the audio source and where the decibel reading was recorded. That's why manufacturers often include a distance in the maximum output rating, as in "110dB (decibels) at 10 feet." A volume of 60dB is roughly equivalent to the quiet of a golf course. Dance clubs average between 100 and 110dB. For most people, painful sound levels begin at 120dB. At 140dB, run for your life—a jumbo jet is about to land on your head.

Power per channel: Often, a speaker system's power per channel (reported in watts) has more to do with marketing than audio quality. Indeed, an inefficient speaker might use a lot of power to generate average volume levels, while an efficient speaker might use only an average amount of power to generate superior volume levels. Producing bass frequencies always requires more power than producing treble frequencies, which is why subwoofers may draw 65W while satellites may draw only 25W. All of these variables should tell you that the power-per-channel spec is a vague measure of speaker quality at best. As a general rule, though, higher numbers in the power-per-channel spec indicate better-designed speakers.

Input connectors: PC speakers are usually equipped with 1/8-inch "mini" plugs that connect directly into the jacks of your soundcard. Most PC speakers plug into the analog connectors, but some can work with digital connections. These speaker sets have a built-in analog-to-digital converter, and they connect with a mini plug or a S/PDIF digital input that uses an RCA plug. Dolby Digital speakers often come with a box that contains an amplifier, a Dolby Digital decoder, and a digital-to-audio converter, and they often connect to a soundcard with a single optical input. Some PC speakers also have auxiliary inputs, so you can connect more than one PC or other device.

WIRELESS LAN



Standards: If you plan to set up a wireless LAN using hardware from more than one company, be sure it all follows the same standard. The two most popular Wi-Fi standards are 802.11b and 802.11g. 802.11g networks are faster, and the equipment should be backwards-compatible with 802.11b. 802.11a operates in the 5GHz range, but isn't backwards-compatible with the other standards.

Frequency range: This is the area of the radio spectrum in which your wireless kit works. Wi-Fi and Bluetooth operate in the 2.4GHz spectrum, which is also shared by some cordless phones. Microwaves can also cause interference in that region and can affect the range of Wi-Fi kits.

External interfaces: This details the means by which your router or bridge connects to the Internet. Most routers include a standard RJ-45 port that connects to a 10/100baseT LAN. Some also include an internal modem so you can dial into your ISP.

- **Standards:** 802.11b, Wi-Fi
- **Data transmission rate:**
11Mbps/5.5 Mbps/
2 Mbps/1Mbps
- **Frequency range:** 2400-2483.5MHz
- **Max distance between terminals:** 100 feet indoors, 200 feet outdoors
- **External interfaces:** V.90 56K modem, 10/100baseT
- **Router or bridge:** Router

Data transmission rate: Usually listed in megabits per second, this is the speed at which your wireless connection moves data. As you move farther from the base station, the speed of the connection will drop. Those diminishing speeds are also listed.

Max distance between terminals: This is simply the maximum distance at which the LAN kit will work, usually reported for both indoors and outdoors. FYI: We've found the indoor settings listed to be very optimistic, especially in crowded urban areas.

Router or bridge: Wireless Ethernet access points are available as either bridges or routers. A bridge is like any other section of network cable—it does nothing but pass data from your wired LAN to your wireless LAN. If you use a bridge, you need an IP address for each wireless machine. A router can share a single IP address with more than one wireless machine by using Network Address Translation (NAT).

Audio DSP chipset: The digital signal processing (DSP) chip determines the basic features of a soundcard. Creative Labs' Sound Blaster Audigy 2 uses the CA0102 DSP chipset, which caters to digital-music enthusiasts by offering such features as DVD-Audio playback. Among soundcards, there's Creative Labs and then there's everybody else, so the EMU10K1 (in the original Audigy) and the CA0102 are ubiquitous. However there are challengers, with several soundcard makers including Turtle Beach and Hercules offering products based on another DSP from Crystal Semiconductors. Soundcards from Philips and Yamaha make their own DSPs for exclusive use in their own soundcards.

Hardware voices/hardware audio channels: This is the number of audio streams that a soundcard can play back simultaneously. A single audio stream can be anything from a sound effect to a character vocalization in a game to individual musical notes in a MIDI synthesizer. Most soundcards support 64 hardware voices, which means they can play up to 64 different sounds at one time. Some manufacturers claim simultaneous playback of up to 256 audio streams, but that figure usually combines hardware voices and software voices. Hardware voices run on the soundcard only, while software voices rely on system resources (i.e., your PC's processor and memory). Performance in demanding applications such as 3D games suffers when your soundcard relies on software voices, so be sure your soundcard supports at least 64 hardware voices.

Input/output connectors: PC soundcards output audio at "line level," so you can't connect a soundcard directly to a speaker and get significant volume. Fortunately, most PC speaker sets have a built-in amplifier that brings the audio signal up to "speaker level." If you don't have a set of PC speakers, you can connect the soundcard's outputs to a stereo receiver, which also has a built-in amplifier. In all cases, you'll have to match the soundcard's connectors to your speakers' or stereo receiver's connectors. Most PC soundcards are equipped with 1/8-inch "mini" connectors, to which most PC speaker sets can be directly connected. Some soundcards, such as Creative's Sound Blaster Audigy 2 Platinum eX and Hercules' Game Theater XP, come with "breakout boxes" that attach to the soundcard and offer many additional connector options, such as RCA connectors for stereo receivers and optical pass-through connectors for Dolby Digital 5.1 speaker sets.

SOUNDCARDS

- **Audio DSP chipset: CA0102**
- **ADC/DAC resolution and sampling rate: 24-bit audio at 192KHz**
- **Hardware voices/hardware audio channels: 64**
- **3D audio formats supported: DirectSound3D, EAX 2.0, EAX Advanced HD**
- **Input/output connectors: 1/8-in., S/PDIF, optical pass-through**

ADC/DAC resolution and sampling frequency: Even if you create music on your PC and play it through digital speakers, all audio must at some point be converted to analog in order for you to hear it. All soundcards support signal conversion, both analog-to-digital (ADC) and digital-to-analog (DAC), but not all have the same resolution and sampling frequency, which are measured in bitrate and hertz, respectively. The higher the resolution and sampling frequency offered by your soundcard, the more precise your PC can be in audio reproduction. Accept nothing less than CD quality in these categories: 16-bit resolution, and a 44.1KHz sampling frequency (most consumer-level soundcards support sampling frequency up to 48KHz.)

3D audio formats: When attached to a set of PC speakers that includes at least four speaker boxes, most soundcards can render 3D or "positional" audio, which generates sounds from any direction around a listener. During gaming or DVD-watching, positional audio sounds like you're standing in the middle of all the action. A good soundcard will support DirectSound3D, EAX (now at version 3.0), and A3D. DirectSound3D, which is part of Windows' DirectX suite, provides a standardized and relatively simple way for programmers to create 3D positional audio. Creative's EAX extends DirectSound3D with additional audio processing features.

The image shows the retail box for the Creative Sound Blaster Audigy 2 Platinum eX soundcard. The box is orange and blue, featuring the product name in large, stylized letters. A photograph of the soundcard itself is shown, highlighting its various ports and connectors. The box also lists several key features and specifications.

- **Audigy™ 2 Internal Drive:** All the analog and digital ports you'll need for simple desktop connectivity including a super-fast SB1394/FireWire™ port
- **DVD-Audio:** The only PC solution to enable the Advanced Resolution™ era of 24-bit music fidelity with 192kHz in stereo and 96kHz in 5.1
- **106dB SNR:** The best Sound Blaster™ clarity ever, rivaling home-theater audio quality for music, games and movies
- **6.1 Surround Sound:** Experience superior multi-channel audio from MP3s, CDs, 3D games and Dolby Digital™ EX movies with a rear center speaker
- **Creative MediaSource™ Player:** The most exciting features yet with library search, automatic playlist volume matching and hiss removal for MP3s
- **Audigy™ 2 Chip & EAX™ ADVANCED HD™:** The ultimate platform for delivering unparalleled audio realism from the hottest gaming titles and pure 24-bit/96kHz recording to capture subtle details in your audio creation

Expanded Connectivity and 24-bit/192kHz DVD-Audio with Pure 106dB SNR for Playback, Recording and 6.1 Surround Gaming!

HARD DRIVES



Capacity: Even a hard drive's advertised size can be misleading. In the hard-drive industry, 1MB is defined as 1 million bytes, not the more technically accurate 1,048,576 bytes. So what does this mean to you at the end of the day? Well, if you're buying a 75GB drive, be aware that if you believe 1MB to be 1,048,576 bytes, your "75GB" hard drive is closer to 72GB. Better yet, just get a 200GB drive and don't sweat the missing few gigs.

Buffer size: This is the amount of memory, or cache, that's used to store recently read data, or buffer data, that's being written to the disk. Many drives today come with a generous 8MB of cache, but after that, diminishing returns actually make the difference inconsequential. However, super-large buffers do come into play when running servers.

Spindle speed: This describes how quickly a hard drive can spin its disk platters (which are attached to a shaft or spindle), and is measured in revolutions per minute (rpm). Most consumer hard-drive speeds range from 5400rpm to 15,000rpm, with the average performance of an IDE drive ringing in at 7200rpm. A drive's spindle speed and areal density are among the most important specs to consider, because the two combined essentially determine the personality of the drive. A higher spindle speed typically suggests faster drive performance, but not always. To wit, a drive with a high spindle speed and low areal density might actually deliver less throughput than a drive with a low spindle speed and high areal density—in some cases. That stated, given the specifics of the models currently on the market, you should always take a 7200rpm drive over a 5400rpm drive.

Sustained (or sequential) transfer rate: This tells you how quickly a hard drive can serve up a contiguous file and is usually expressed in gigabytes per second. Sustained data rate is among the most telling hard drive specs—but it can be easily misrepresented. Sustained transfer rates describe the speed at which a hard drive can move a single large file that's laid out sequentially on the disk. But if you typically work with smaller files that are scrambled all over the disk, seek time is a more relevant spec.

- **Capacity: 75GB**
- **Seek time: 8.5ms**
- **Buffer size: 2MB**
- **Interface: ATA/100**
- **Spindle speed: 7200rpm**
- **Areal density: 11Gb per square inch**
- **Sustained (or sequential) transfer rate: 37GB/second**

Seek time: Measured in milliseconds (ms) and usually expressed as an average, seek time tells you how long it takes for a drive's read heads to move back and forth across the platters that actually store the drive's data. Seek time can be an important factor in determining how fast a drive performs, but most modern 7200rpm drives have very similar seek times. They all seem to hover in the 9ms range, and the difference between an 8.5ms and 9ms seek time is negligible. You won't see real differences until you're looking at a drive with a seek time in the ultra-high-performance 5ms range (such as that offered in the Seagate X15).

Interface: Don't be fooled by boxes emblazoned with the promise "133MB/s transfer rate!" An ATA/133 drive can indeed handle 133MB/sec transfers, but you'll never experience such speeds during actual use. The problem is that the internal machinery of even the fastest IDE hard drives can't pump data at such a fast rate. In fact, none of the ATA/133 drives currently available will hit even 50MB/sec transfers during peak operation. This doesn't mean you shouldn't buy ATA/133—it is, after all, the fastest hard-drive technology available. But ATA/100 is more than adequate until Serial ATA drives take over. If your immediate consideration is speed, pay more attention to areal density, the number of platters, spindle speed, and seek time.

Areal density: This defines the amount of data that can be packed onto a square inch of magnetic platter surface. The closer together you can corral your data, the higher the areal density. Usually expressed in gigabits per square inch, higher densities generally indicate faster drives. For example, if you double the areal density of a disk platter, the drive head needs to move only half as far in order to read or write the same amount of data on the platter. Increasing areal density also allows for a reduction in the drive's platter size, which gives you other benefits, such as reduced power consumption.

SYSTEM REQUIREMENTS

If game companies told you what your system *really* needed in order to get the most out of their games, you probably wouldn't buy the games at all. The "System Requirements" example below was pulled directly from the box of *Battlefield 1942*.

CPU: A 500MHz Pentium III? For *Battlefield 1942*? Maybe if you don't mind games with frame rates slower than filmstrips. We think that even the recommended 800MHz Pentium III is a farce. To get the most from a game, our rule of thumb is to triple the minimum requirement or double the recommended CPU.

Memory: 128MB of RAM isn't enough for Windows XP alone, much less running a game on top of the OS. We recommend no less than 512MB for optimal performance under Windows XP.

CD-ROM: It's often said that few games take advantage of CD-ROM speeds beyond 4x because they use only low-quality video and because most of a game's levels are installed on your hard drive. For the most part, this adage holds up. The reasoning, however, doesn't take into account the long install times of new games. If a game takes two CDs to load, you'll cut your time by a third—possibly by half—by using a CD-ROM that spins at 32x or better.

Hard drive: The box specs rarely lie in this case. If a game requires 650MB to run, you'd better have that much hard-drive space available. But also consider the fact that many games can now be loaded onto the hard drive in their entirety—where they'll lay claim to a helluva lot of space. We recommend you have between three and 10 times more space available than the game says it needs. Since hard drives tend to slow down when they're almost full, you'll get the most performance from a drive that isn't packed.

MINIMUM

- **CPU:** Pentium III 500/AMD Athlon
- **Memory:** 128MB
- **CD-ROM:** 4x
- **Videocard:** 32MB supported Direct3D and Hardware and Transform & Lighting capable video card with DirectX 8.1 compatible sound card
- **Hard drive:** 1.2GB free space

RECOMMENDED

- **CPU:** Pentium III 800 / AMD Athlon
- **Memory:** 256MB
- **CD-ROM:** 16x
- **Videocard:** 64MB supported Direct3D and Hardware and Transform & Lighting capable video card with DirectX 8.1 compatible sound card
- **Hard drive:** 650MB free space

Videocard: As we may have mentioned, game publishers tend to distort reality when describing the minimum videocard needed to render their masterpieces. We'd be surprised if a 32MB card could run any triple-A game titles. If they did, it would be because you'd turned off so many of the game's details, you might as well load up the text-based *Zork*. Our recommended bare minimum is a GeForce4 Ti 4200 or a Radeon 9000 Pro.



How To...

■ ■ ■ A step-by-step guide to tweaking your PC Experience

BUILD A PC Entertainment CENTER



MAXIMUM PC
TIME TO COMPLETION
04:30
HOURS MINUTES

BY WILL SMITH

Throw away your game console, DVD player, and TiVo. Here's how to make the perfect PC for living room deployment

HP and Alienware are doing it, so why aren't you? Media Center PCs—which play DVDs, record live TV, and manage entire digital music collections—are the latest craze.

Unfortunately, the Windows XP Media Center Edition isn't available for retail purchase. You can get it only if you buy a prefab Media Center system from a system manufacturer. The Media Center extension to the basic WinXP operating system is expressly designed to work with a hardware remote control unit and lets you use your PC as a turnkey digital media command center. We

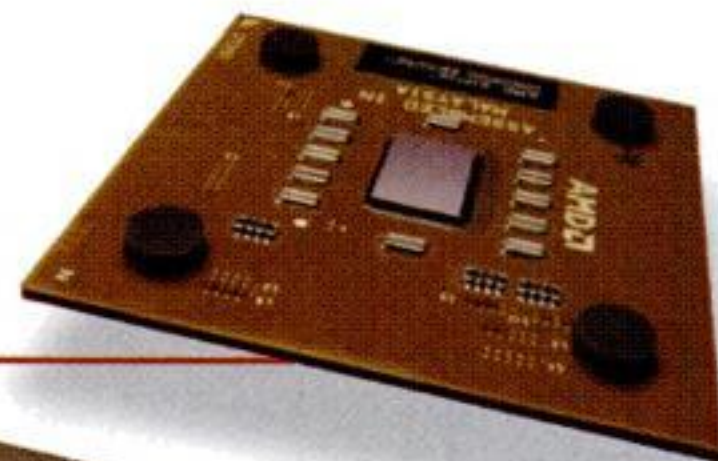
can understand why the Media Center software isn't going retail: Our OEM friends tell us it works with just a very short list of approved hardware configurations.

The good news is that you don't need Media Center software to enjoy Media Center features. The software just streamlines the entertainment experience for couch-potato convenience. This month, we'll show you how to build your own PC entertainment center, using readily available, off-the-shelf parts.

Shopping List

We used the following parts, but substitutions are discussed later in the article.

- ▶ Shuttle SN45G nForce2 XPC (a bare-bones mini-case with a preinstalled nForce2 motherboard)
- ▶ Athlon XP 2000+ processor: **\$100**
- ▶ 512MB PC2400 DDR SDRAM: **\$100**
- ▶ 200GB Maxtor DiamondMax Plus 9 hard drive: **\$275**
- ▶ Sony DRU510A DVD recorder: **\$300**
- ▶ ATI All-in-Wonder 9800 Pro videocard: **\$450**
- ▶ Mini headphone-jack extension cable: **\$10**
- ▶ A TV, HDTV, or PC monitor
- ▶ 5.1 speaker set with a digital decoder
- ▶ MusicMatch Jukebox Plus: **\$30**



Components in Detail

Before you configure your entertainment center, you need to decide exactly what you want to do with it. We wanted to play DVDs; play, pause, and record live TV; play digital music; enjoy an occasional game; and archive everything to a recordable DVD. We tailored our project PC to these specifications, but in the following paragraphs, we tell you where you can scrimp if you want to ditch some of these features.

CPU, CHIPSET, AND MEMORY

The nForce2 core-logic chipset can do Dolby Digital 5.1 encoding in real-time, so we were intent on buying a bare-bones Shuttle case that features this chipset. This chipset is compatible only with Athlon CPUs, so if you don't want to be locked into the AMD platform, you might consider the Shuttle SB51G, which runs Pentium 4s.

As long as you have sufficient CPU speed and memory capacity (1.5GHz and 256MB, respectively), you should be fine, even if you're using ATI's software encoder for TV recording duties. If you're *not* planning to use your PC as a TiVo replacement, you can

skimp on CPU power. DVD and MP3 playback are much less CPU-intensive than on-the-fly video encoding.

3D ACCELERATION AND TV FUNCTIONALITY

For TV viewing and recording and 3D acceleration in a single AGP slot, there's really no better alternative than the ATI All-in-Wonder 9800 Pro. It combines the awesome 3D speed of a Radeon 9800 Pro with the multimedia prowess of previous All-in-Wonder products, and even includes a handy wireless remote control.

If you're looking for the TV viewing goodness, but don't need top-shelf 3D power, consider the ATI All-in-Wonder VE. It has all the same TV functionality as the 9800 Pro without the expensive 3D accelerator.

MASS STORAGE

When it comes to your storage subsystems—i.e., your hard drive and optical drive—bigger is always better. However, if you're not planning on using your entertainment PC for TV recording and "timeshifting"

duties, your hard drive can be significantly smaller. While 40 hours of recorded TV can consume 128GB of hard drive space in a flash, even a massive MP3 collection with more than 3,000 tunes will absorb just 15GB of space.

If burning DVDs isn't your bag but you still want to watch DVDs and burn music CDs, you should get a CD-RW/DVD-ROM combo drive. We recommend the Samsung SM-332. It will burn CDs at 32x, and rips audio quickly, too. It's also significantly cheaper than the Sony DVD-RW/+RW drive.

INPUT OPTIONS

Even though the All-in-Wonder ships with a good remote, you'll still want a reliable wireless keyboard and mouse, for games if nothing else. Logitech's Cordless Keyboard is quite nice and reasonably priced at \$40. We're also fans of the Gyratation Ultra mouse, which works as either a normal optical mouse or by waving it around in mid-air. It's perfect for couch gaming! Gyratation also sells a compact wireless keyboard, but we haven't yet tested it.

Putting It All Together

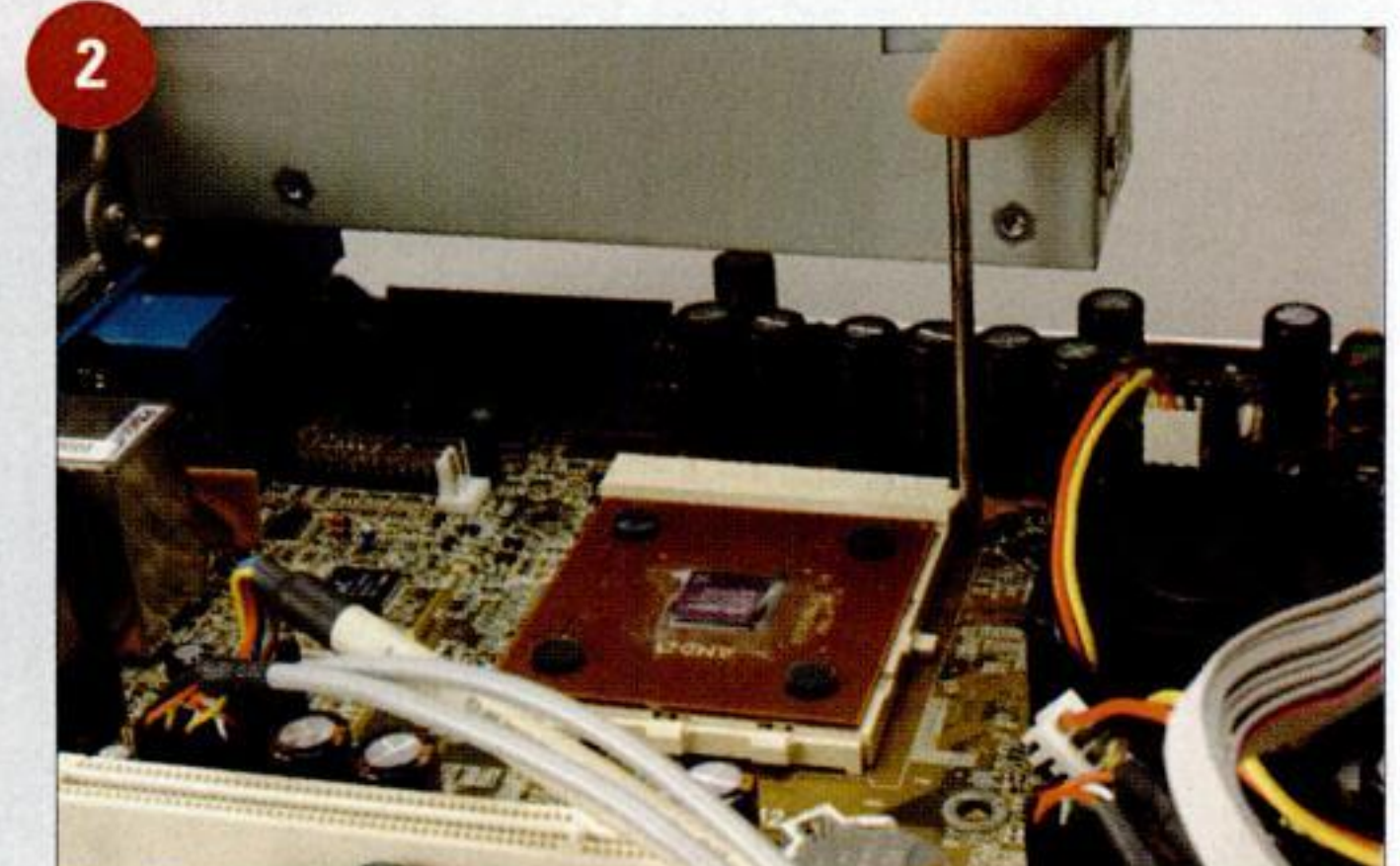
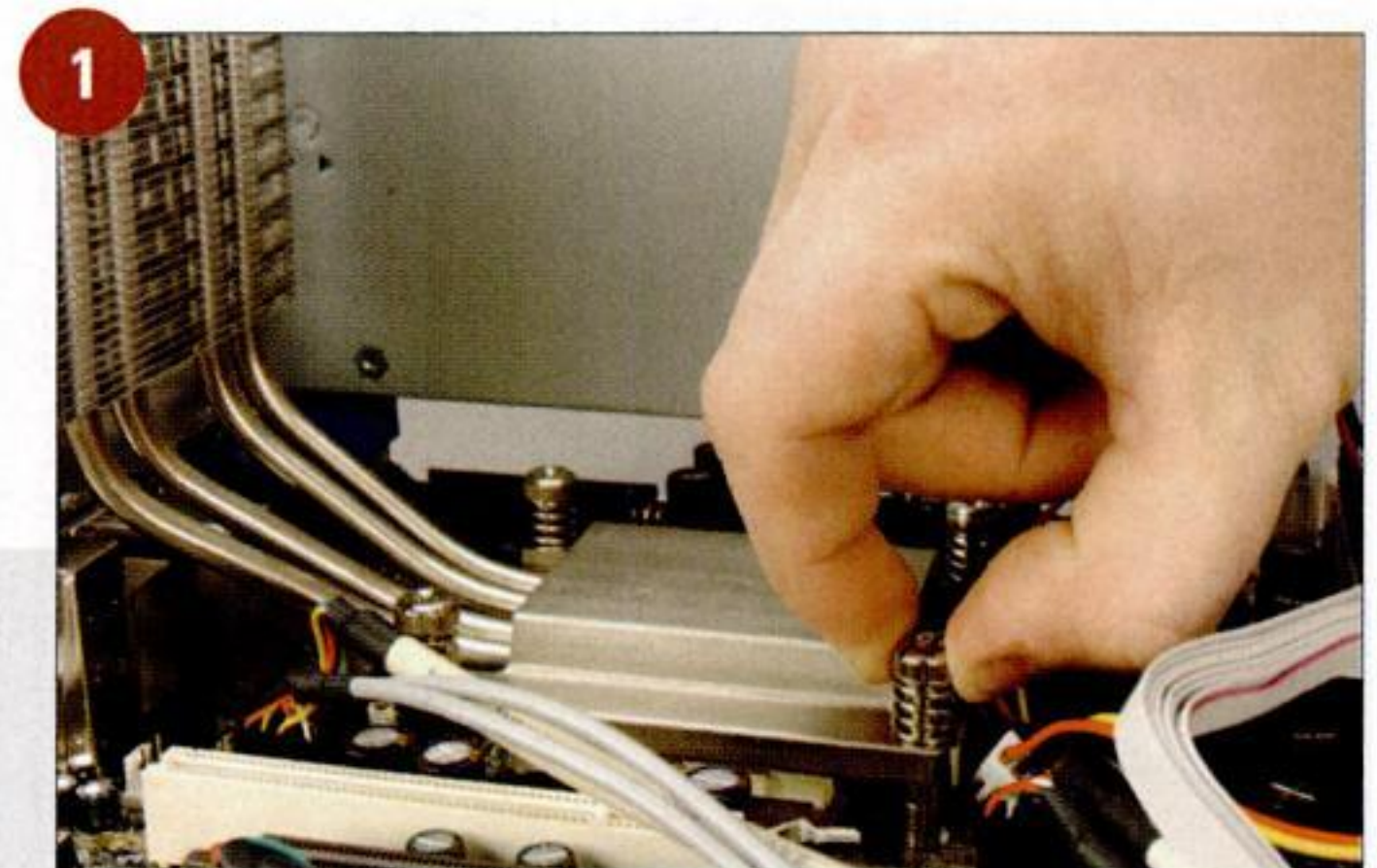
You'll need to install the CPU, memory, drives, and AGP card before you can start using your new PC. If you've never built a PC before, see our "Build It" feature on page 8. If you have built a PC before, but are nervous about digging around the Shuttle box's guts, here's a short cheat sheet.

STEP ONE CPU AND MEMORY

First, you'll need to open your Shuttle case and remove the drive cage (the big U-shaped metal thing near the optical bays at the front of the case). Next, you'll need to remove the CPU cooling assembly. First, unscrew the thumbscrews holding the fan mount on the outside of the back of the case. Second, lift the fan assembly off the radiator, and remove the screws that hold the heat pipe to the CPU socket (figure 1).

Now you can lift the CPU locking lever and gently drop the CPU into its socket, making sure not to force it in. Push the lever back down until it clicks into place (figure 2). After the CPU is seated, apply a small amount of thermal grease to the core, then replace the CPU cooling mechanism. Make sure not to over-tighten the heatsink when you lock it down. You should tighten the screws by hand, and then give them a quarter twist with your screwdriver. Over-tightening can kill your Athlon.

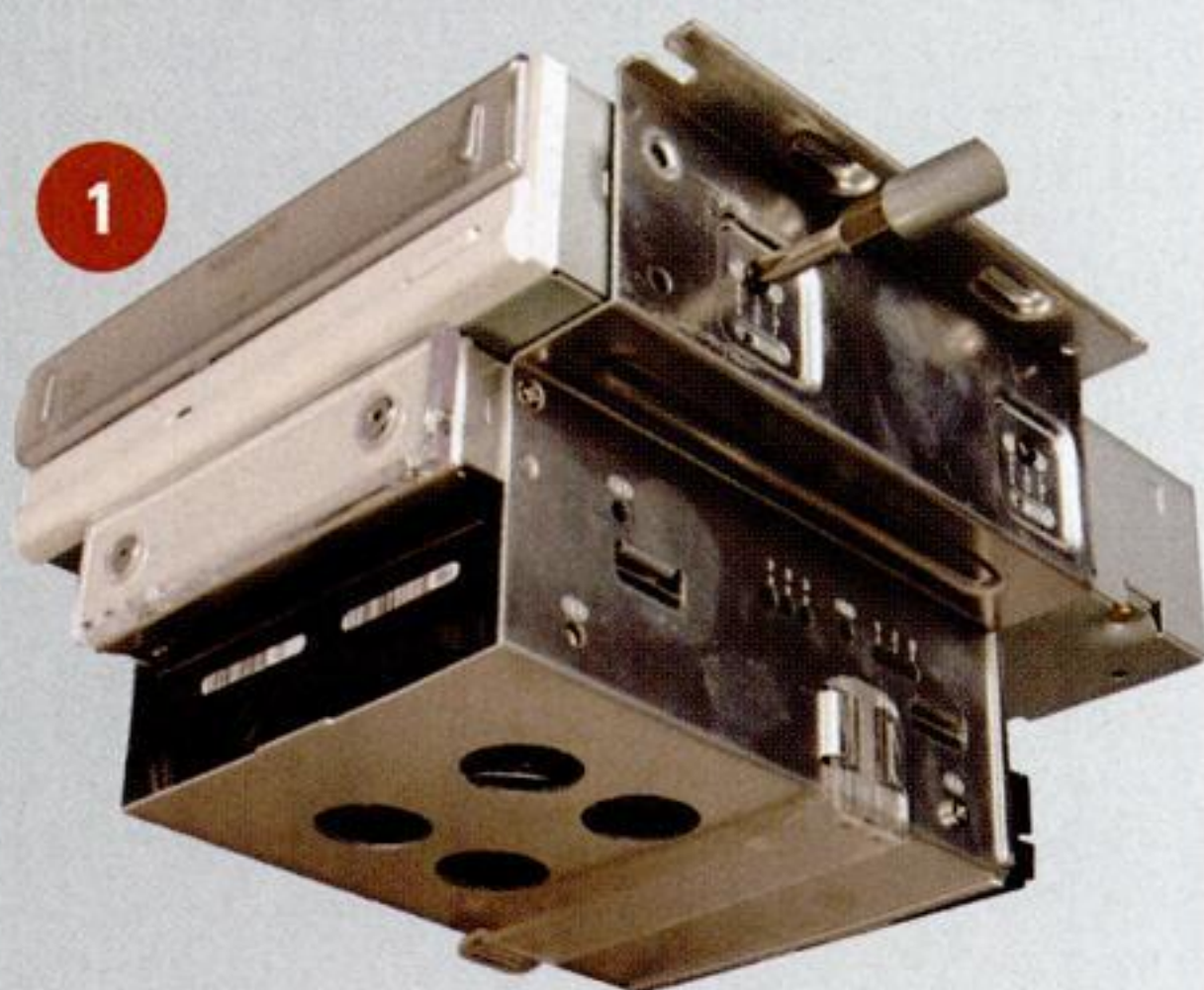
Next, install the memory. All you need to do is slide it into the slot, then push down until it clicks into place. It's an absolute pain in the ass to install the RAM after you've reinstalled the drive cage, so make sure you do things in order!



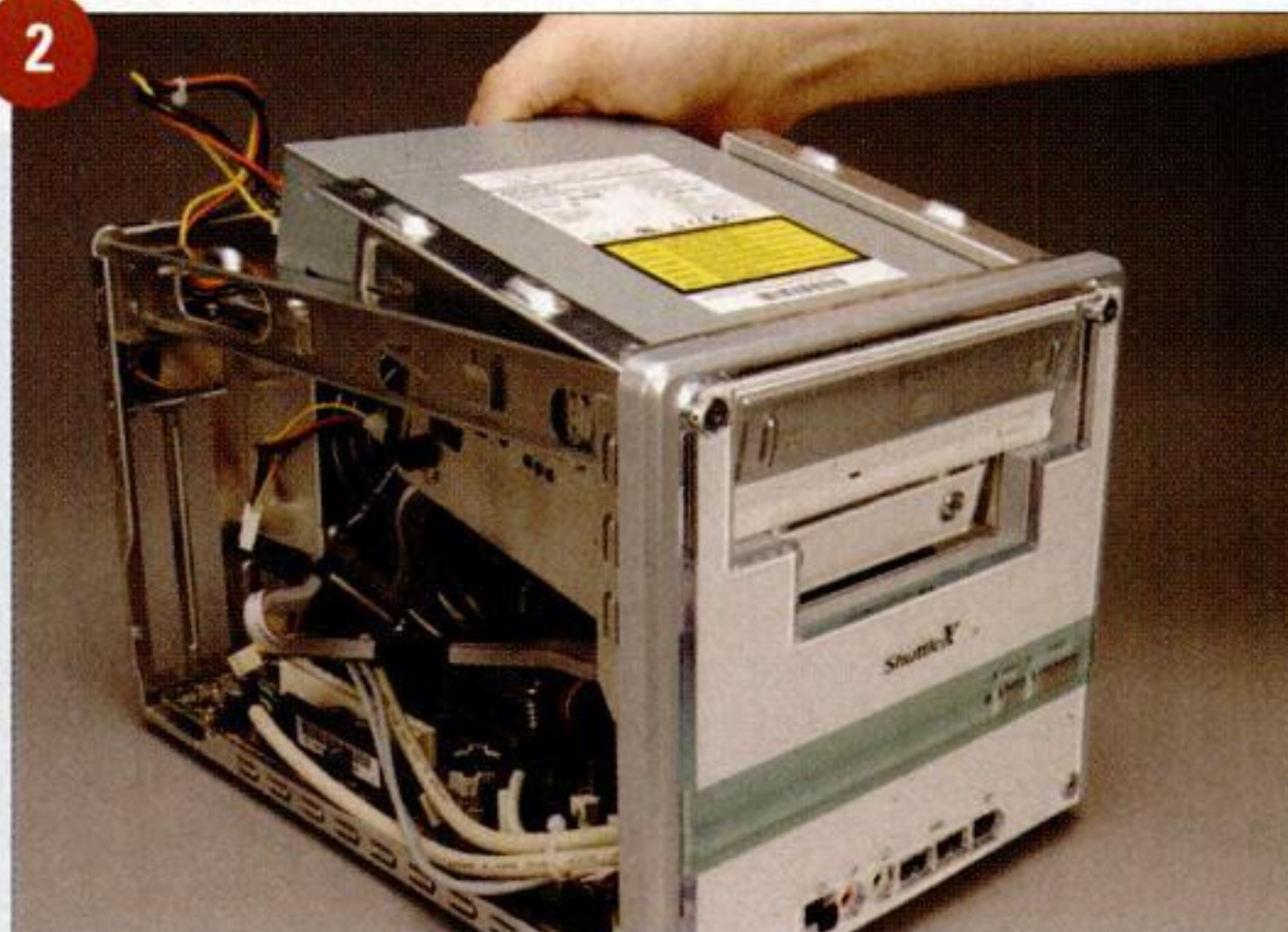
STEP TWO INSTALLING YOUR DRIVES

Now that your CPU and memory are installed, it's time to plug in your drives. Take a look at your Shuttle's drive cage. We recommend putting the hard drive in the bottom slot and the optical drive in the top slot, and forgoing a floppy drive—1.44MB just isn't enough space to fool with these days. There are specific holes lined up in the bottom slot of the drive rack for the hard drive, but you'll need to make sure the optical drive's front panel lines up properly with the front of your Shuttle case. You can do this by lining up the bezel of the drive with the 3.5-inch slot cover that's mounted in the drive caddy (figure 1).

Once the drives are mounted in the drive cage, you'll need to



2



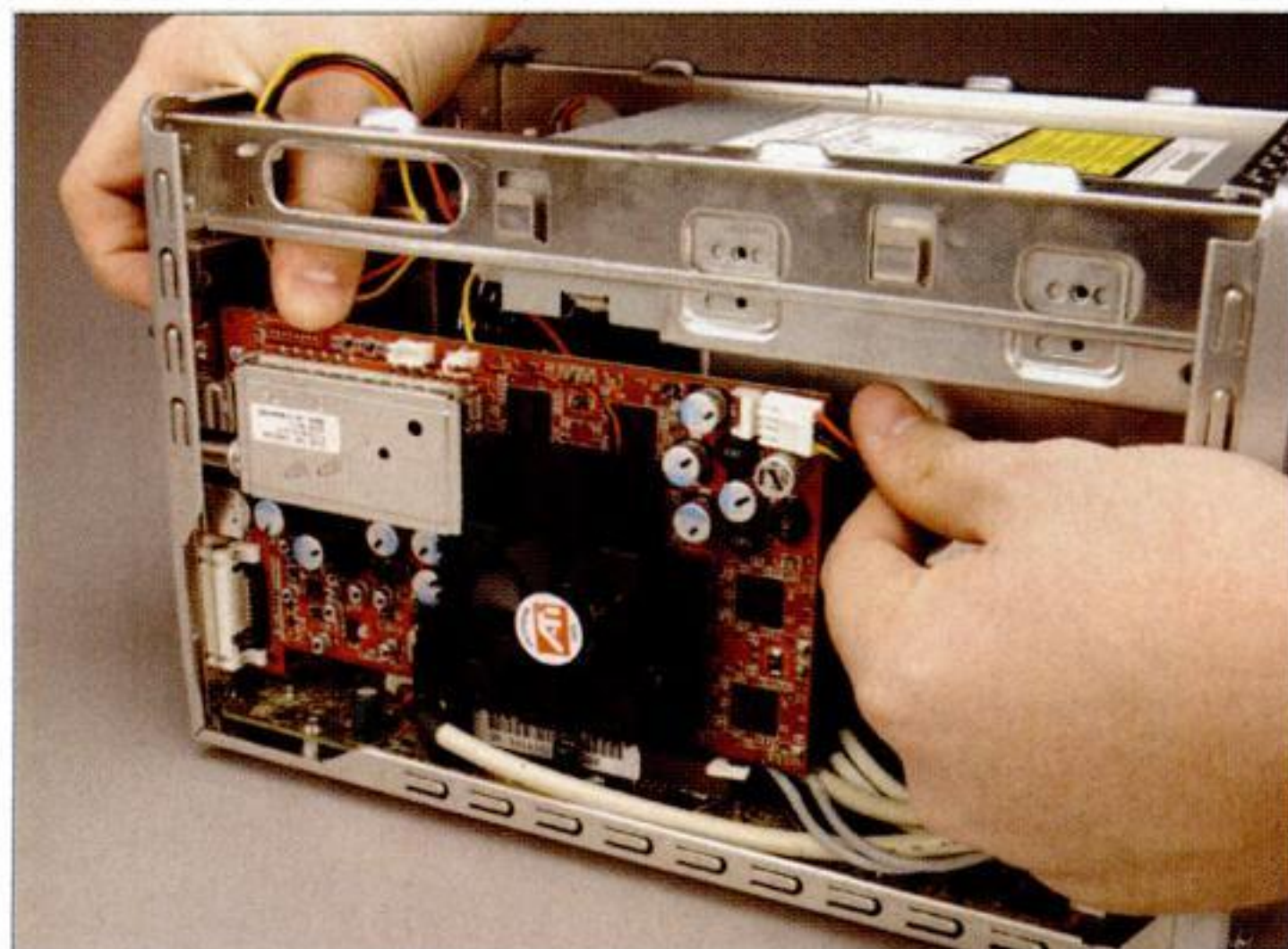
slide the cage into the case. Before you do, make sure the jumpers for the drives are set properly. The hard drive should be set to be master and the optical drive should be set to slave. We recommend plugging the IDE and power cables into your hard drive before you set the cage in your case. They're difficult to access once the drive cage is screwed down.

Slide the drive cage into the case bezel first, and then lower the back end until it's flush with the top of the case (figure 2). Be very careful not to force it. You may need to adjust the IDE and power cables to get everything in. If you're using an All-in-Wonder 9800 Pro, you'll also need to keep a floppy power connector available on the left side of the case to give the board the additional juice it needs. Once the cage is in the case, you can slide it all the way forward and lock it in place using the screws on the top.

STEP THREE INSTALLING YOUR VIDEOCARD

All that's left on the hardware front is the All-in-Wonder 9800 Pro. Turn the case around until you have easy access to the left side, and remove the slot cover from the AGP slot's faceplate. Next, slide the 9800 into the slot and screw it into the mounting bracket. Last, you'll want to plug a floppy power connector into the All-in-Wonder's power jack (see image).

Make sure you pick the proper output dongle for the video-card. If you're going to use a monitor or normal TV as your display, use the black dongle. HDTV users will need the red dongle. Connect the audio output on the dongle to the microphone input on the front of the PC using your headphone extension cable.



STEP FOUR CLOSING THE CASE

Everything's installed, so you can plug the keyboard, monitor, and power into the PC and power it up to make sure it passes the power on self test (POST). If the PC POSTs properly and all your drives are detected by the BIOS, you can pull the power and put the cover back on the Shuttle box. Make sure you don't catch any wires when you're closing the cover, and that the sides get into their guide grooves.

Getting the Software Working

Next up, we'll install the software you'll need to run your entertainment PC. You'll need a copy of Windows XP Home or Professional and some of the bundled software that comes with the videocard (the ATI drivers, *Pinnacle Studio 8*, and *Mediator 7*).

INSTALLING WINDOWS

Installing Windows XP is generally pretty easy. If you have a hard drive that's larger than 133GB, you'll need to pay close attention during the hard drive partitioning sections of the install.

If a hard drive is larger than 133GB, anything beyond the 133GB mark won't show up in the Windows XP partitioning tool. To fix this, we recommend that you create a small 40GB partition using the XP installer, install the OS on that partition, install the chipset drivers for your motherboard, and then create a large partition using the rest of the drive.

Why create just a 40GB install partition? Because we plan on using that drive only for the OS, the important applications, and digital music. Even a massive music collec-

tion probably won't be more than 20 or 30GB, leaving plenty of room for Windows XP and your applications on the C: partition. Don't partition or format the rest of the drive until Windows and the chipset drivers are installed.

Once your Windows install is up and running, go into the Computer Management tool by going to Start, then Run, and typing `compmgmt.msc`. From there, go to the Storage section and look under Disk Management. Right-click the unformatted section of the drive, select Create partition, and make a primary partition. Then you'll need to format your new partition by right-clicking it and choosing Format.

After you've installed XP, you'll want to install Service Pack 1 (available at www.windowsupdate.com) and reboot. You'll also need to install your chipset drivers and ATI's All-in-Wonder 9800 Pro drivers, rebooting as prompted.

RECOMMENDED SOFTWARE

Once your drivers are installed, we recommend installing the software bundled with

the All-in-Wonder. The ATI *Multimedia Center* and remote control software will let you use the PC without a keyboard and mouse, and seamlessly switch between watching TV, listening to music, and viewing DVDs.

The first time you launch the ATI'sTV app, you'll be prompted to start a setup wizard. When you're in the wizard, make sure you set ATI'sTV timeshifting app to use the large hard drive partition you just created instead of your smaller C: partition. By isolating the video on the large partition, you'll maximize the amount of video you can record as well as minimize the drive fragmentation that inevitably occurs during TV timeshifting.

Pinnacle Studio and *Mediator*—which are bundled with the All-in-Wonder—will let you encode captured TV shows in the proper MPEG-2 format so they will work on set-top DVD players. You'll then be able to burn your videos and captured TV shows to disk using *MyDVD 4.5*, which is bundled with the Sony drive we recommend.

Finally, we like *MusicMatch Jukebox* to play all our digital music, organize playlists, manage ID3 tags, and burn songs to CD.

Output Options

Now that your media center is set up, you need to configure it for your particular output options. Everyone knows how to plug a normal PC monitor into a PC, but using a normal TV or an HDTV as your display can be tricky. Besides discussing display connectors in this section, we'll also show you how to hook up your home stereo speakers to your PC (in the event your "multimedia speakers" are \$10 throwaway jobs).

Before you disconnect the monitor you used during setup, make sure you set the resolution in the Display control panel to the minimum. That will help ensure that you'll be able to see and configure your new display when you connect it.

USING AN HDTV AS YOUR MONITOR

The All-in-Wonder 9800 Pro includes an HDTV output that will work with any HDTV at any of the HDTV resolutions. The dongle is red, and has five outputs. You'll use the red, green, and blue RCA outputs to connect to your HDTV. The orange is a coaxial digital output, which you won't use. The blue mini-headphone plug needs to be connected to the microphone input on the front

of the PC (if you don't connect it, you won't get any audio when you're watching TV).

USING A NORMAL TV

The resolution of a normal TV is pretty shameful in this age of 1600x1200 flat panels. However, the low resolution doesn't preclude you from using your entertainment PC to watch TV, view DVDs, and listen to tunes. Just connect either the RCA composite or S-video outputs of the videocard to your TV (your videocard should have the necessary cables).

The max resolution most TVs will display is 800x600 at 60Hz, so you'll need to make sure that your PC's display settings are adjusted to these specs before you connect your TV to your PC. Also, the OS is much easier to use if you set it to use large fonts and icons. Go to the Appearance tab in Windows' Display Properties control panel, and change the font size to Extra Large. Then click the Advanced button, select the Icon item, and change the size from 32 to 45. Press OK and then press Apply.

USING A DIGITAL 5.1 SPEAKER RIG

If your home theater receiver has a free

Toslink optical SPDIF input, use it—it's the best interface for PC connections, and it's simple as pie to use. All you need to do is plug one end of the optical cable into your receiver and the other end into your PC. Then go into the nForce control panel (by double-clicking the system tray icon), and make sure that the Digital output box is checked. Select the proper digital input on your receiver, and you should be good to go.

USING AN ANALOG SPEAKER RIG

To connect your PC to a stereo, you'll need a mini headphone-to-stereo-RCA cable. You can get these at Radio Shack for less than \$10. Plug the headphone end into your PC's main sound output (the green jack), and the other end into a spare set of inputs on your receiver.

If your receiver has 5.1 analog inputs, you might be able to use the analog 5.1 outputs on the back of the Shuttle box and three mini headphone-to-RCA cables. Unfortunately, we weren't able to test this config with the hardware we had in the lab.

Believe it or not, you now have a fully functioning PC that's perfectly outfitted for living room entertainment. Have fun! ■

Look Inside

building the best systems since 1990



What is considered to be a great gaming computer?

Is it its cool case?
Is it its slim monitor?
Is it its sleek speakers?

Well... that would be good.

But to be **GREAT**, it's what is **inside that counts!**

Q: What about performance?

A: "Blistering performance." "A fantastic system for games." -- Rich Brown, CNET.com

Q: What about service?

A: "ABS was the only national PC vendor to earn a rating of Good for service in our latest reader survey." -- Mick Lockey, PC World

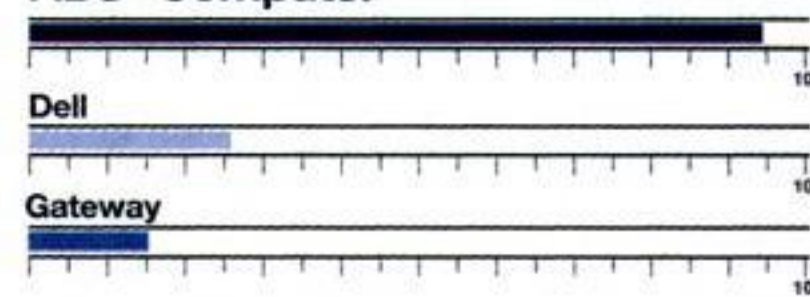
Powered by powerful Intel® Pentium® 4

processor with Hyper-Threading technology.

ABS® Ultimate Gaming systems are the overwhelming choice to power the hottest new games and transform your personal PCs into high-speed professional gaming machines.

Customer Satisfaction

ABS® Computer



>> Source: Resellerratings.com

August 10, 2003

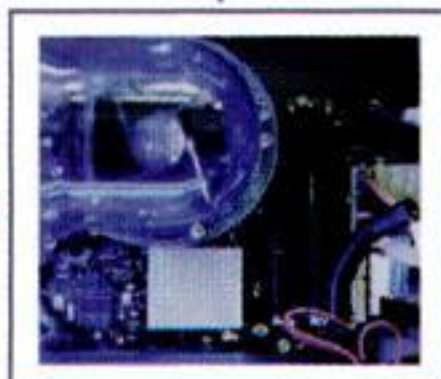
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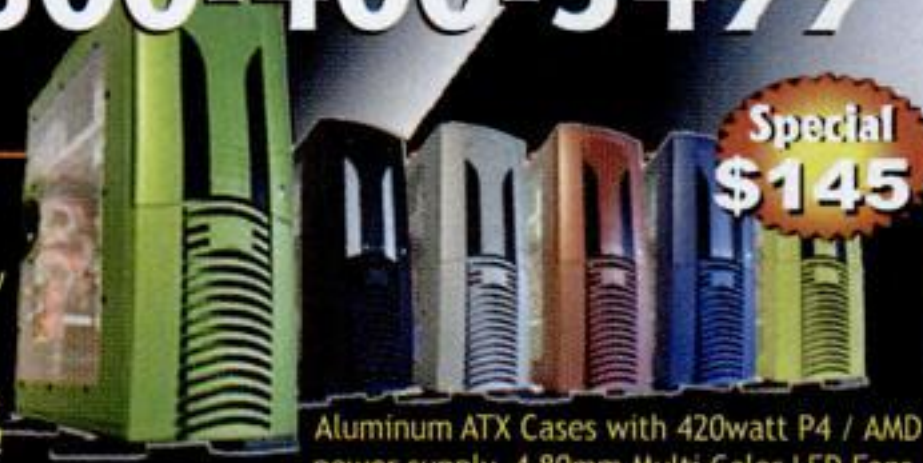
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Processors Step 3

Memory Step 4

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	Gigabyte	GA8IG1000P	\$135	GA8KNXP	\$239
	Intel	D875PBZLK	\$179	D865GLCL	\$123
	AOpen	MX46533V	\$73	AX45GMAX	\$173
	Asus	A7N8XX	\$88	A7V8XX	\$70
	Gigabyte	GA7VKMP	\$68	GA7N400PRO	\$126
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Celeron 2.4 GHz 128 cache	\$92	P4	2.53GHz 512k 533	\$216
Celeron 2.5 GHz 128 cache	\$97	P4	2.66GHz 512k 533	\$218
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P4 2.4GHz 512k 533	\$186	P4	3.2GHz 512k 800	\$697
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XP 2200+ Retail 266Mhz	\$82	XP 3200+ Retail 400Mhz	\$486	
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XP 2600+ Retail 333Mhz	\$114	Opteron 244 1.8Ghz 64bit	\$744	
XP 2700+ Retail 333Mhz	\$152	Check out our website for all the NEW AMD Opteron Motherboards		
XP 2800+ Retail 333Mhz	\$198			

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Branded PC133	512MB 64x64 133MHz	\$59	
DDR Memory			
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Crucial PC2100	256MB DDR 266MHz	\$52	
Crucial PC2100	512MB DDR 266MHz	\$89	
Crucial PC2700	128MB DDR 333MHz	\$31	
Crucial PC2700	256MB DDR 333MHz	\$42	
Crucial PC2700	512MB DDR 333MHz	\$94	
Crucial PC3200	256MB DDR 400MHz	\$64	
Corsair PC3200	512MB DDR 400MHz	\$99	
Kingston PC3500	256MB Hyper X 434MHz	\$91	
Kingston PC3500	512MB Hyper X 434MHz	\$165	

HardDrives Step 5

Video Cards Step 6

Sound Cards Step 7

Maxtor	80GB	7200rpm	ATA 133	6Y080LO	\$85
Maxtor	120GB	7200rpm	ATA 133	6Y120LO	\$107
Maxtor	160GB	7200rpm	ATA 133	6Y160PO	\$176
Maxtor	200GB	7200rpm	ATA 133	6Y200PO	\$239
Maxtor	160GB	7200rpm	SATA	6Y160MO	\$199
Maxtor	250GB	7200rpm	ATA 133	7Y250PO	\$315
Seagate	40GB	7200rpm	ATA 133	ST340014A	\$72
Seagate	80GB	7200rpm	ATA 133	ST380011A	\$85
Seagate	120GB	7200rpm	ATA 133	ST3120026A	\$128
Seagate	80GB	7200rpm	SATA	ST380023AS	\$125
Seagate	120GB	7200rpm	SATA	ST3120026AS	\$140
Seagate	160GB	7200rpm	SATA	ST3160023AS	\$190
WD	80GB	7200rpm	ATA100	WD800JB	\$97
WD	120GB	7200rpm	ATA100	WD1200JB	\$119
WD	180GB	7200rpm	ATA100	WD1800JB	\$193
WD	200GB	7200rpm	ATA100	WD2000JB	\$216
WD	250GB	7200rpm	ATA100	WD2500JB	\$311

EVGA	256A8N328AX	GEFORCE FX 5900 256MB DDR VO/DVI	\$476
EVGA	128A8N308T4	GEFORCE FX 5200 128MB DDR VO/DVI	\$141
EVGA	256A8N318T3	GEFORCE FX 5600 256MB DDR VIVO/DVI	\$188
Gainward	ULTRA6508X	GEFORCE4 ULTRA/650 128MB DDR	\$195
Gainward	VG4T142DTF	GEFORCE4 ULTRA/650 64MB TV/DVI	\$150
Gainward	ULTRA 750-8XXP	GEFORCE4 T14800 SE 128MB 8XAGP	\$220
AOpen	FX5800DV128	GEFORCE FX 5800 128MB DDR II TV/DVI	\$370
AOpen	9105210310	GEFORCE FX 5600 256MB VIVO/DVI	\$193
AOpen	900510B55	GEFORCE 2 MX400 64MB DDR VIVO/DVI	\$42
MSI	FX5800TD128	GEFORCE4 FX5800 128MB DDR VI/DVI	\$350
MSI	FX5900TD128	GEFORCE4 FX5900 128MB DDR DTV/DVI	\$409
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Iomega	120GB	7200rpm	32394 \$209
WD	120GB	7200rpm	wd1200B05 \$215
Maxtor	250GB	5400rpm	S01J250 \$338
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Iomega	250MB	Zip Ext USB Drive	31310 \$124
Iomega	750MB	Zip Ext USB Drive	32324 \$164

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Microsoft Intellimouse Explorer \$49			
Logitech MX700 RF Cordless Optical Mouse w/Base \$70			

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Promedia51	5.1 THX 500w	\$399	
GMXD51	5.1 GMX 108dB	\$299	
Logitech	Pulse350	3 Piece 25w	\$30
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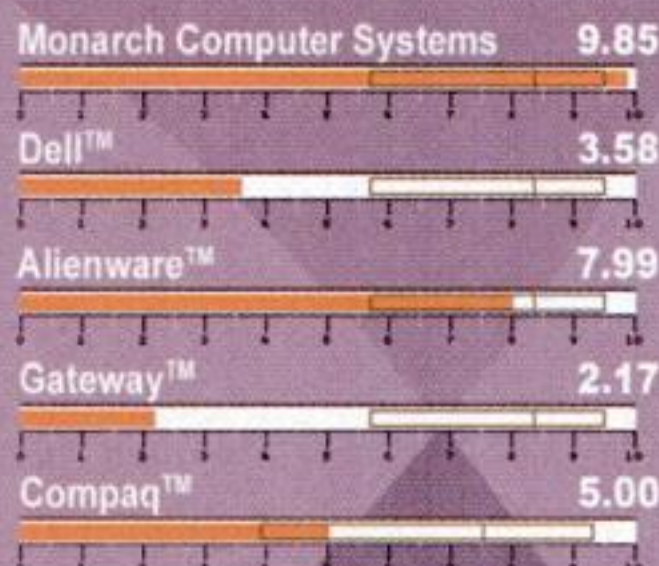
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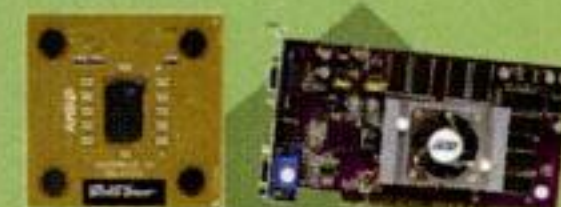
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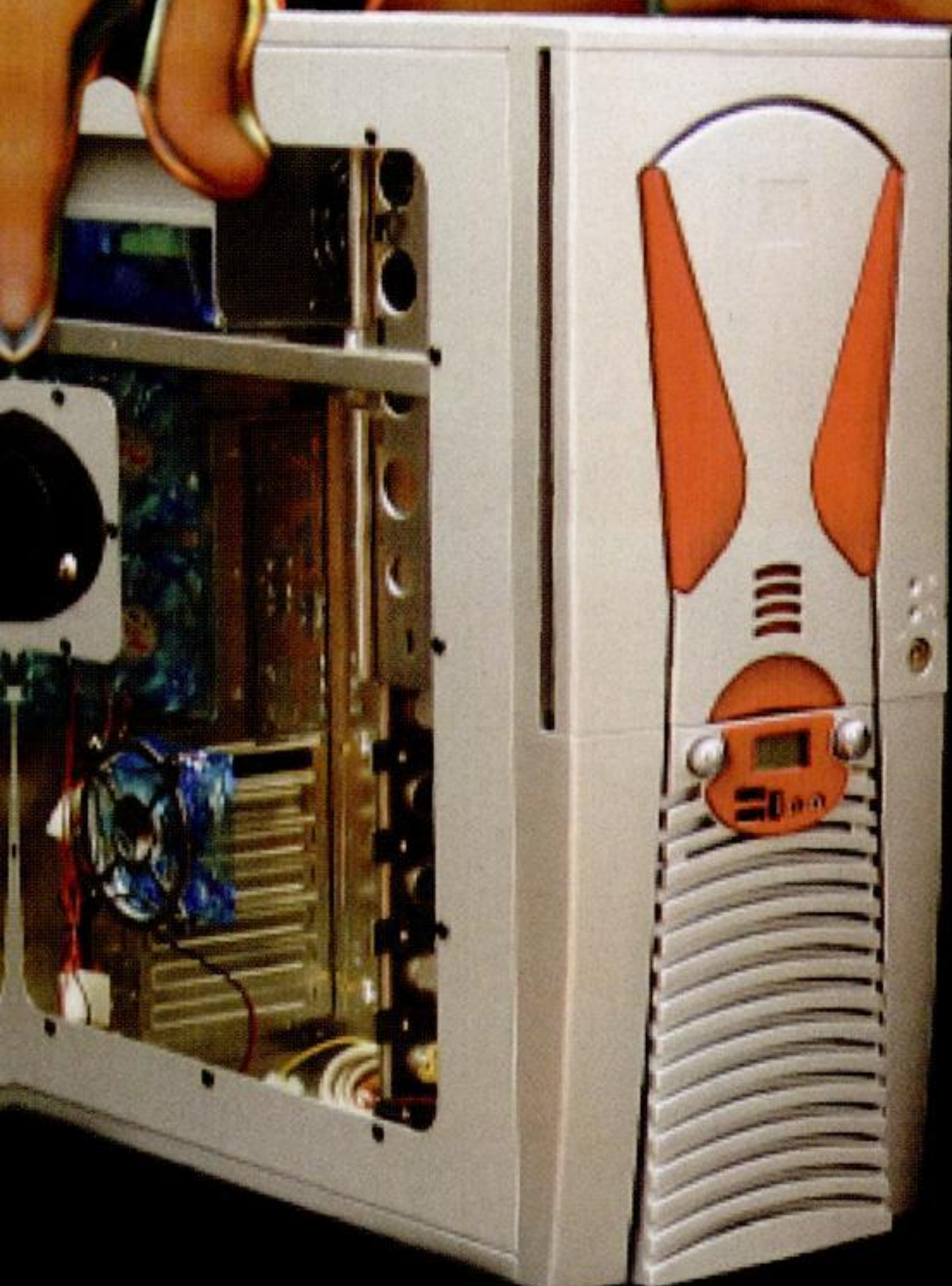


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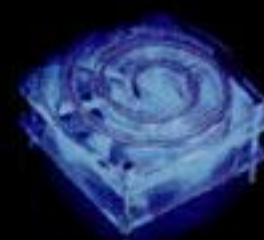


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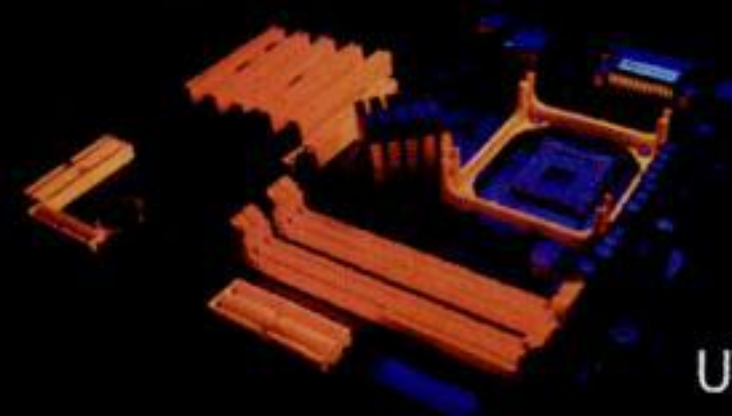
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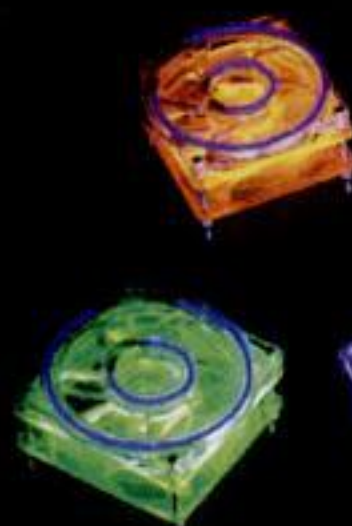
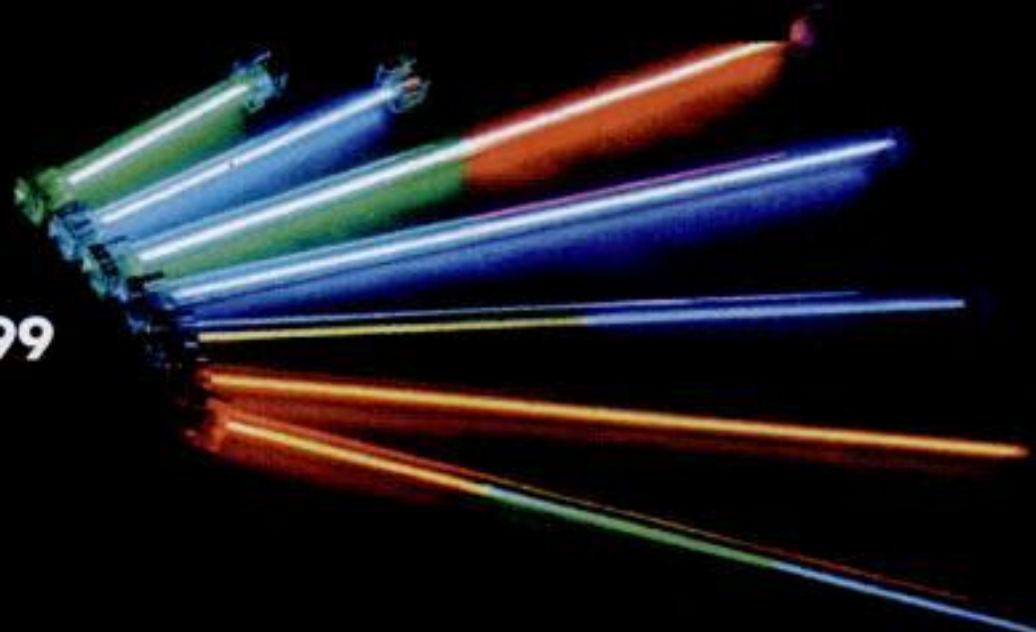


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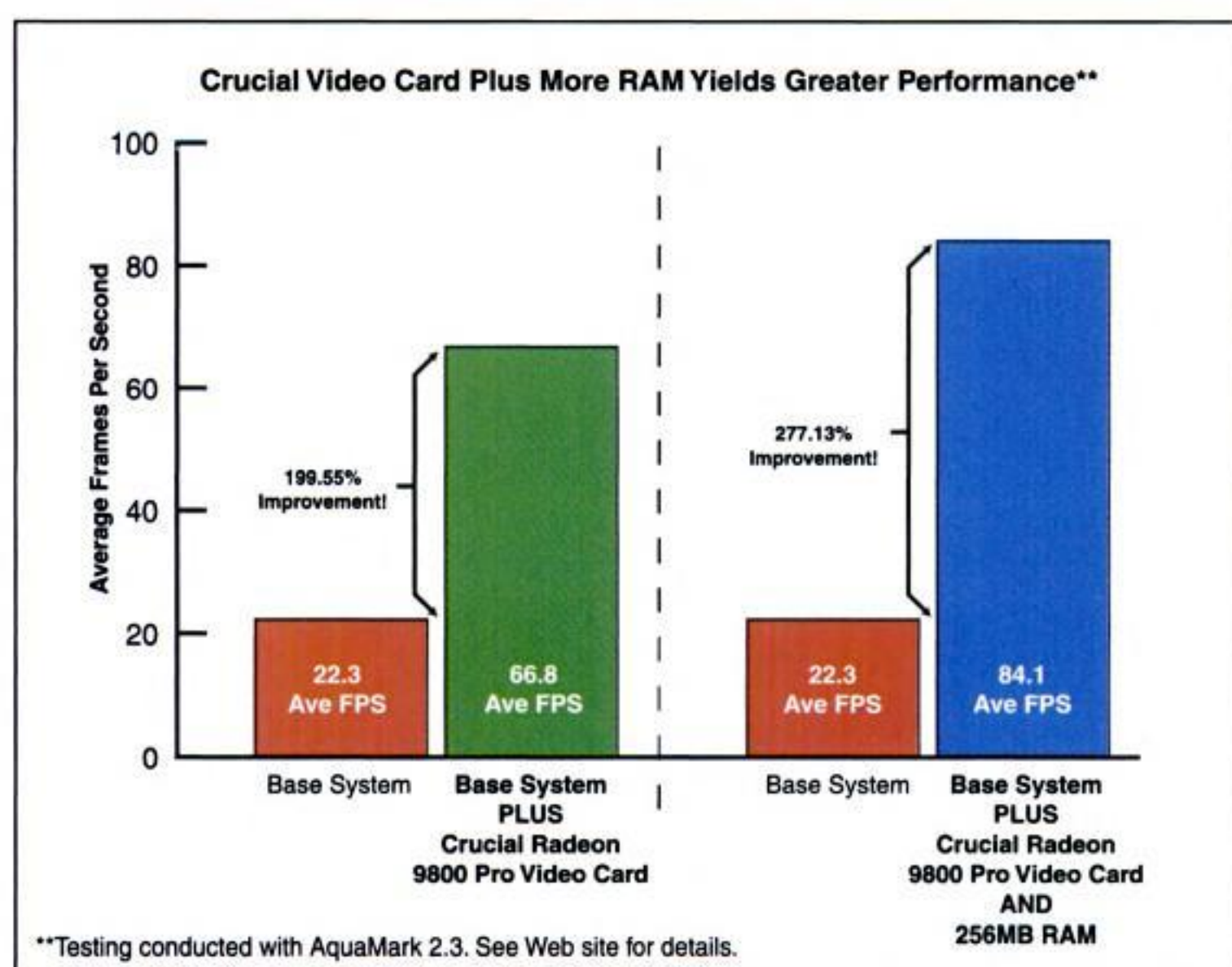
The Fab-Me-Fabulous Six-Layer Dream Shoppe™ does not support IEEE-approved components. The Fab-Me-Fabulous Six-Layer Dream Shoppe™ should only be used with My Lil' Mobo™ Fun Fab component kits including Mother Moxley's Ole Time Transistor Factory™, Miss Lady Merryweather's Core-Logic Cottage™, and Duchess Busy-Mittens EX Inductor Oven™. The Fab-Me-Fabulous Six-Layer Dream Shoppe™ is intended for demonstration purposes only, and should not be used for mission-critical computing environments, including corporate file servers, early warning disaster systems, and military defense installations.

"Down with Tehama!"
"Down with Granite Bay!"
"I'm gonna make a mobo my own way!"

Two Secret Weapons Your LAN Party Buddies Don't Want You To Have...

New tests reveal the power of this killer combo!

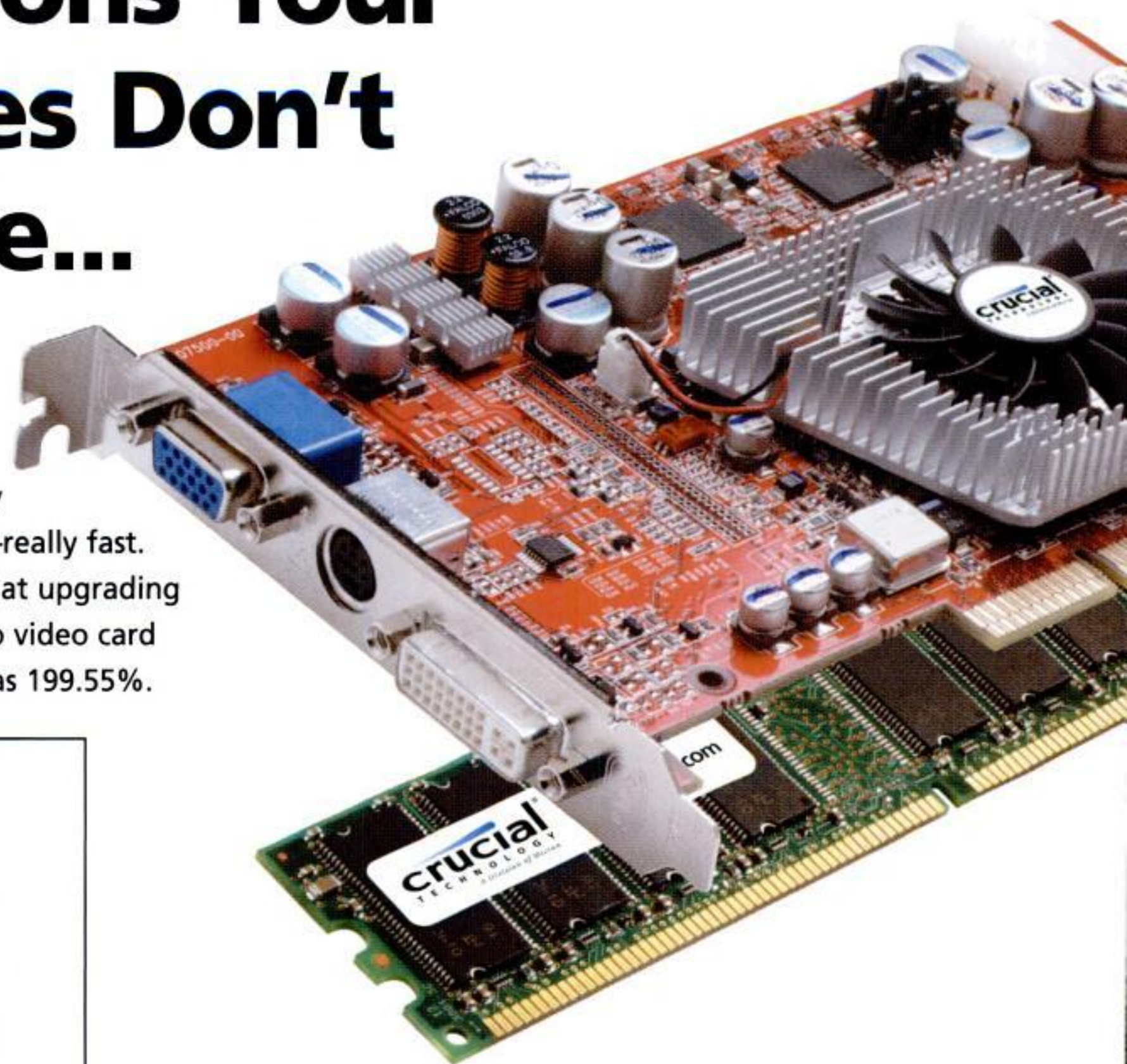
Okay, the first "secret" isn't really so secret. You probably know very well that the Crucial Radeon™ 9800 Pro video card is fast—really fast. In fact, tests conducted by the Crucial Performance Lab show that upgrading from a GeForce2 GTS 32MB card to the Crucial Radeon 9800 Pro video card can improve average frame rate benchmark scores by as much as 199.55%.



The second secret revealed!

But the tests showed something else. Something so subtle, we're embarrassed to say we almost missed it. According to the tests, maximum performance can be achieved by upgrading *two components at the same time*—the video card and the RAM. With the Crucial Radeon 9800 Pro video card and an additional 256MB of RAM, our test system showed a 277.13% improvement over the base system in average frame rate benchmark scores.

So now you know. Upgrade your video card to a Crucial Radeon 9800 Pro and get a big boost in performance. Throw in some more RAM while you're at it, and get a bigger boost in performance. Now that's a killer combo your LAN party buddies will be drooling over!



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